

The dengue prevention, surveillance and control programme in the state of Morelos, Mexico

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Abstract

The objective of this paper is to examine the dengue prevention, surveillance and control programme in the state of Morelos, Mexico in the light of Mexican and international guidelines, as well as literature published on the issue.

We conducted a literature search with relevant search terms to provide background material for this study. Furthermore, we reviewed official Mexican norms and manuals concerning the dengue programme. Through semi-structured interviews with key informants in the Health Services of Morelos, we tried to establish how the programme is implemented in Morelos. Informants were also interviewed on their experiences with and opinions on the programme. Findings were discussed considering relevant norms and literature.

We found that much regard is currently given to the issue of dengue in Morelos, due to an increasingly concerning epidemiological situation. Epidemiological surveillance is well-functioning, and new computerised systems help in analysis of data. Entomological surveillance and control are carried out after international norms, and efforts are made to establish entomological indices with better predictive value. The formally organised community participation programme (Patio Limpio) may not be working optimally for several reasons, including underlying cultural and social conditions. Other means of social intervention and education including public information campaigns seem to be prioritised, and may have larger impact. The issue of integrating institutions outside the health sector in the dengue prevention work is addressed. A future challenge will be optimising intersectorial cooperation in order to remedy underlying socioeconomic problems that contribute to the concerning dengue situation in Morelos.

Contents

| | |
|---|--------|
| Abstract | 3 |
| Content | 4 |
| Glossary | 8 |
| 1. Introduction | 10 |
| 1.1. Dengue in the world today | 10 |
| 1.2. Motivation | 10 |
| 1.3. Objectives | 10 |
| 2. Background | 10 |
| 2.1. Transmission and disease dissemination | 10 |
| 2.2. The disease | 11 |
| 2.3. Historical distribution of dengue | 11 |
| 2.3.1. Early history of dengue | 11 |
| 2.3.2. History of dengue in America | 12 |
| 2.3.3. Dengue in Mexico | 12 |
| 2.4. Dengue prevention, surveillance and control programmes in America | 12 |
| 2.4.1. Traditional approaches | 12 |
| 2.4.2. Revision of strategies during the 1990s | 13 |
| 2.5. Architecture of the Mexican health care system | 14 |
| 2.6. The Mexican state of Morelos | 14 |
| 2.6.1. Geography of Morelos | 14 |
| 2.6.1.1. Territory and topography | 14 |
| 2.6.1.2. Climate | 15 |
| 2.6.1.3. Population | 15 |
| 2.6.2. Structure of the health care systems in Morelos | 15 |
| 2.6.3. The epidemiology of dengue in Morelos | 16 |
| 2.6.3.1. Before 2008 | 16 |
| 2.6.3.2. The outbreak of 2008 | 16 |
| 2.6.3.3. Current situation – 2009 | 16 |
| 2.6.3.4. Cases reported according to notifying institution | 17 |
| 3. Materials and methods | 17 |
| 3.1. Scope of this section | 17 |
| 3.2. Strategy | 17 |
| 3.3. Literature search | 17 |
| 3.4. Additional literature | 18 |
| 3.5. Document studies | 18 |
| 3.6. Interviews | 18 |
| 3.6.1. Selection of informants | 18 |
| 3.6.2. Interview circumstances | 19 |
| 3.6.3. Interview design | 19 |
| 3.6.4. Interview analysis | 20 |
| 3.7. Observation and participation | 20 |
| 4. SINAVE – the Mexican system of epidemiological surveillance | 20 |
| 4.1. Structure | 20 |
| 4.2. Information system of SINAVE. Routine handling of epidemiological data | 21 |
| 4.3. Levels of urgency for notification | 21 |
| 4.4. Epidemiological case studies and outbreak studies | 22 |
| 4.5. Classification of cases in SINAVE | 22 |

| | |
|---|----|
| 4.6. Laboratories of SINAVE | 22 |
| 4.7. Special subsystems of SINAVE | 23 |
| 5. National guidelines for dengue prevention, surveillance and control | 23 |
| 5.1. Components of the dengue prevention, surveillance and control programme | 23 |
| 5.2. Epidemiological surveillance | 24 |
| 5.2.1. Operational case definitions of dengue | 24 |
| 5.2.2. Notification of DF/DHF cases | 25 |
| 5.2.3. Notification of dengue outbreaks | 25 |
| 5.2.4. Monitoring clinics | 26 |
| 5.2.5. Routines for laboratory diagnostics of DF/DHF | 26 |
| 5.2.6. Management of detected DF/DHF cases | 27 |
| 5.2.7. Self-evaluation scheme | 27 |
| 5.2.8. Treatment | 27 |
| 5.3. Entomological surveillance | 27 |
| 5.3.1. Larval surveillance | 27 |
| 5.3.2. Surveillance of adult mosquito population | 28 |
| 5.3.3. Estimation of dengue transmission risk | 29 |
| 5.4. Vector control measures | 29 |
| 5.4.1. Types of vector control measures | 29 |
| 5.4.2. Larval control | 29 |
| 5.4.2.1. Physical larval control measures | 29 |
| 5.4.2.2. Chemical larval control measures | 29 |
| 5.4.2.3. Biological larval control measures | 30 |
| 5.4.2.4. Duties of the larval control workers | 30 |
| 5.4.3. Control of the adult mosquito population | 30 |
| 5.4.3.1. Indications for adult mosquito control measures | 30 |
| 5.4.3.2. Mode of operation | 30 |
| 5.4.3.3. Choice of adulticides | 30 |
| 5.5. Patio Limpio – community-based participatory vector control efforts | 31 |
| 5.5.1. Objectives of the Patio Limpio programme | 31 |
| 5.5.2. Phases of the Patio Limpio programme | 31 |
| 5.5.2.1. Role of the promoter | 31 |
| 5.5.2.2. Phase 1 | 31 |
| 5.5.2.3. Phase 2 | 32 |
| 5.5.2.4. Phase 3 | 32 |
| 5.5.2.5. Phase 4 | 32 |
| 6. The dengue control programme as implemented in Morelos | 33 |
| 6.1. Sources of information | 33 |
| 6.2. Epidemiological surveillance of dengue in Morelos | 34 |
| 6.2.1. Routines for notification and laboratory diagnostics | 34 |
| 6.2.2. Registration of data in the Unified Information Platform | 34 |
| 6.2.3. Use and analysis of data in the Unified Information Platform | 34 |
| 6.2.4. Lacking registration of cases from private physicians | 34 |
| 6.2.5. Individual follow-up of cases | 35 |
| 6.2.6. Agreements with neighbouring states on the exchange of information | 35 |
| 6.2.7. Joint assessment of the epidemiological situation on state level | 35 |
| 6.2.8. Assessment of the epidemiological situation during outbreaks | 36 |
| 6.3. Entomological surveillance and vector control in Morelos | 36 |
| 6.3.1. Objectives, organisation, resources and priorities of the vector control sector | 36 |
| 6.3.1.1. Goals for entomological surveillance | 36 |

| | |
|---|----|
| 6.3.1.2. Organisation | 36 |
| 6.3.1.3. Main focus..... | 36 |
| 6.3.1.4. Classification of geographical areas according to priority..... | 36 |
| 6.3.2. Larval control brigades | 37 |
| 6.3.2.1. Level of activity | 37 |
| 6.3.2.2. Entomological surveillance through larval indices | 37 |
| 6.3.2.2.1. Use of <i>Stegomyia</i> indices | 37 |
| 6.3.2.2.2. Establishment of new indices | 37 |
| 6.3.3. Insecticide spraying | 38 |
| 6.3.3.1. ULV indoor spraying | 38 |
| 6.3.3.2. Large-scale spraying | 38 |
| 6.3.4. Biological control measures..... | 39 |
| 6.3.5. Control measures during outbreaks | 39 |
| 6.4. The Regional Vector Control Centres (CERECOVES)..... | 39 |
| 6.4.1. Organisation..... | 39 |
| 6.4.2. Role of the CERECOVES | 39 |
| 6.4.3. Research..... | 40 |
| 6.4.3.1. Research objectives..... | 40 |
| 6.4.3.2. Research areas..... | 40 |
| 6.4.4. Intersectorial cooperation | 40 |
| 6.4.5. Concrete projects of the CERECOVE | 41 |
| 6.4.5.1. Surveillance with ovitraps..... | 41 |
| 6.4.5.2. Trials with biological larval control measures | 41 |
| 6.4.5.3. Establishment of new entomological indices and studies of container productivity..... | 42 |
| 6.4.5.4. School projects..... | 42 |
| 6.5. Health promotion strategies and community participation programmes | 42 |
| 6.5.1. Resources of the health promotion sector..... | 42 |
| 6.5.2. Patio Limpio | 43 |
| 6.5.2.1. Coverage | 43 |
| 6.5.2.2. Community workshops and recruitment of activators | 43 |
| 6.5.3. The “Public Buildings Free of Breeding Sites” programme | 44 |
| 6.5.4. Public information campaigns | 44 |
| 6.5.4.1. Means of communication..... | 44 |
| 6.5.4.2. Message profile and slogans | 45 |
| 6.5.4.2.1. Development of the main message..... | 45 |
| 6.5.4.2.2. Attempts to ensure uniform information | 45 |
| 6.5.5. School programmes | 46 |
| 6.5.6. Work aimed at local authorities to improve infrastructure | 47 |
| 6.5.6.1. Infrastructure | 47 |
| 6.5.6.2. Container collection programmes | 47 |
| 7. Reports and observations on experiences with the dengue prevention, surveillance and control programme in Morelos | 47 |
| 7.1. Sources of information | 47 |
| 7.2. On epidemiological surveillance | 48 |
| 7.2.1. Sensitivity and efficacy of epidemiological surveillance | 48 |
| 7.2.2. Introduction of the NS1 serological test for dengue diagnostics | 48 |
| 7.2.3. The Unified Information Platform..... | 48 |
| 7.3. On epidemiological surveillance and control | 49 |
| 7.3.1. Usefulness of the <i>Stegomyia</i> indices..... | 49 |

| | |
|--|----|
| 7.3.2. The problem of unavailable premises (“closed households”) | 49 |
| 7.4. On efficacy of control measures | 49 |
| 7.4.1. Confounding factors when assessing efficacy of control interventions | 49 |
| 7.4.2. Use of insecticides | 50 |
| 7.4.2.1. Large-scale spraying | 50 |
| 7.4.2.2. Urgent spraying of houses where dengue cases are reported..... | 50 |
| 7.4.2.3. Choice of insecticides | 50 |
| 7.5. On socioeconomic aspects affecting dengue prevention and control work | 51 |
| 7.6. On cultural aspects affecting dengue prevention and control work | 51 |
| 7.6.1. Passivity due to paternalistic politics – the belief that everything is the responsibility of the government | 51 |
| 7.6.2. The impact of information | 51 |
| 7.7. On Patio Limpio | 52 |
| 7.7.1. Reluctance to participate in Patio Limpio..... | 52 |
| 7.7.2. Non-acceptance of the population of being judged by their peers | 52 |
| 7.7.3. Scepticism towards others in urban areas | 52 |
| 7.7.4. The impact of poor economy | 52 |
| 7.7.5. Poor intersubjective reliability of Patio Limpio assessment indices | 52 |
| 7.7.6. Role of the Patio Limpio programme in dengue prevention in Morelos..... | 53 |
| 7.8. Other remarks on the dengue prevention, surveillance and control programme in Morelos | 53 |
| 7.8.1. Action against specific container types | 53 |
| 7.8.2. Need for top-down strategies in the current situation..... | 53 |
| 7.8.3. Activity level..... | 54 |
| 7.8.4. Vaccine trials | 54 |
| 8. Discussion | 54 |
| 8.1. Limitations..... | 54 |
| 8.2. General impression of the dengue prevention, surveillance and control programme in Morelos | 55 |
| 8.3. The dengue prevention, surveillance and control programme in Morelos seen in the light of national and international guidelines..... | 55 |
| 8.4. Specific aspects of the dengue programme in Morelos in the light of literature..... | 56 |
| 8.4.1. Epidemiological surveillance..... | 56 |
| 8.4.2. Swift spraying response | 57 |
| 8.4.3. Entomological surveillance..... | 57 |
| 8.4.4. Vector control measures | 58 |
| 8.4.5. Health promotion and community participation..... | 58 |
| 8.4.6. Demographic and socioeconomic issues | 60 |
| 8.4.7. Use of top-down vector control measures | 60 |
| 9. Conclusions | 60 |
| 10. Acknowledgements | 61 |
| 11. Conflicts of interest | 61 |
| Bibliography..... | 62 |

Glossary

| Abbreviation | Spanish | English |
|--------------|--|--|
| ADE | | Antibody-dependent enhancement |
| BI | | Breteau Index |
| CCA | Coordinación de Control Analítico | Coordination of Analytic Control |
| CDC | | Centre for Disease Control and Prevention |
| CENAVECE | Centro Nacional de Vigilancia Epidemiológica y Control de Enfermedades | National Centre for Epidemiological Surveillance and Disease Control |
| CERECOVE | Centro Regional de Control de Vectores | Regional Vector Control Centre |
| CEVE | Comité Estatal de Vigilancia Epidemiológica | State Committee of Epidemiological Surveillance |
| CI | | Container Index |
| CONACyT | Consejo Nacional de Ciencia y Tecnología | National Council of Science and Technology |
| CONAVE | Comité Nacional para la Vigilancia Epidemiológica | National Committee of Epidemiological Surveillance |
| DALY | | Disability adjusted life years |
| DENV | | Dengue virus |
| DF | | Dengue fever |
| DHF | | Dengue haemorrhagic fever |
| DIF | Sistema Nacional para el Desarrollo Integral de la Familia | National System for Integral Family Development |
| DSS | | Dengue shock syndrome |
| HI | | House Index |
| IMSS | Instituto Mexicano del Seguro Social | Mexican Social Security Institute |
| INDRE | Instituto Nacional de Diagnóstico y Referencias Epidemiológicos | National Institute of Epidemiological Diagnostics and References |
| ISSSTE | Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado | State Employees' Social Security and Social Service Institute |
| LESP | Laboratorio Estatal de Salud Pública | State Laboratory of Public Health |

| | | |
|--------|--|--|
| LNSP | Laboratorio Nacional de Salud Pública | National Laboratory of Public Health |
| MeSH | | Medical Subject Heading |
| NOM | Norma Oficial Mexicana | Official Mexican Norm |
| PAHO | | Pan American Health Organisation |
| RNLSP | Red Nacional de Laboratorios de Salud Pública | National Network of Public Health Laboratories |
| SEDENA | Secretaría de la Defensa Nacional | Ministry of National Defense |
| SEED | Sistema Estadístico y Epidemiológico de las Defunciones | Registry of causes of death |
| SINAVE | Sistema Nacional de Vigilancia Epidemiológica | National System of Epidemiological Surveillance |
| SNS | Sistema Nacional de Salud | National health system |
| SSA | Secretaría de Salud | Ministry of Health |
| SSM | Servicios de Salud de Morelos | Health Services of Morelos |
| SUIVE | Sistema Único de Información para la Vigilancia Epidemiológica | Unified Information System for Epidemiological Surveillance |
| ULV | | Ultra Low Volume, method of applying insecticide as a fine aerosol |
| WHO | | World Health Organization |
| YFV | | Yellow fever virus |

1. Introduction

1.1. Dengue in the world today

Dengue is an infectious disease caused by the dengue virus (DENV), which belongs to the *Flaviviridae*. It is mainly transferred between humans by the mosquito *Aedes aegypti*. This mosquito species, as well as the disease, is widely distributed across the tropical and subtropical world. An estimated 2.5 billion people are currently at risk of being infected, affecting all continents except Europe^{1,2}. Annually approximately 500 000 persons are hospitalised, and the world wide death rate among the affected is approximately 2.5 %. Children account for a considerable amount of the deaths³. During epidemics of dengue haemorrhagic fever (DHF) (see 2.2), the mortality rate can exceed 20%, and infection rates among those not previously exposed to the virus can reach 80%².

The incidence of dengue fever has increased dramatically over the past decades and represents a significant social burden on the societies affected. Having a gross impact on health and health budgets in many subtropical and tropical countries, as well as being detrimental to their economy in general, dengue has become a priority for the public health systems in several countries, and has been listed by the World Health Organization (WHO) in the programme “Disease Control Priorities in Developing Countries”⁴. Estimations have been made that in terms of losses in disability adjusted life years (DALYs), dengue has an impact comparable to tuberculosis, sexually transmitted diseases including HIV and malaria⁵.

1.2. Motivation

Dengue has been a neglected problem for a long time. Currently, it is a serious public health problem with extensive economical consequences in large parts of the world. Thus, we have found it of interest to familiarise ourselves with the public health measures currently employed to limit the impact of dengue. We have chosen to do so through a study of the dengue prevention, surveillance and control programme in the state of Morelos, Mexico, with the kind cooperation of Mexican health authorities. In 2008, Morelos experienced the largest outbreak of dengue in the history of the state. Thus, dengue is a public health problem of great importance, currently receiving a lot of attention in the area. During our stay in Morelos from the 1st of July-14th of August 2009, we have been provided with extensive opportunities to learn from the experiences of public health workers involved in the programme.

1.3. Objectives

In this paper, we will:

- Present some background on dengue as a public health problem, with focus on Latin America and Mexico
- Present the components of the programme for dengue surveillance, prevention and control in the Mexican state of Morelos
- Present the opinions of health workers involved with the programme
- Assess how the programme is carried out compared to the current national and international norms
- Discuss positive and problematic aspects of the programme in the light of published literature

2. Background

2.1. Transmission and disease dissemination

Transmission of dengue may occur throughout the year, but peaks during the rainy season⁶. The vector, the female *Ae. aegypti* (and to a lesser extent also the *Aedes albopictus*), is first

and foremost active after sunset and before sunrise. It may feed on any vertebrate, but is strongly anthropophilic, i.e. it has a strong affinity for feeding on humans⁷. It also tends to feed more than once before oviposition. Thus, it may transmit the virus if it feeds on an infected person and subsequently on a non-infected. *Ae. aegypti* is also a peridomestic species, which means that it prefers to rest inside or close to houses, often on walls, rather than outdoors⁷. It favours areas of stagnant water as breeding sites, like discarded tires, flower vases, cisterns, water tanks, barrels etc.⁷ Hence, a garden or a public area could serve as a breeding site, unless it is kept free of sites with stagnant water.

The actual distribution of the vector is determined by several factors. Some of these are pointed out in numerous studies to be more important:

- Massive population growth and *increased population density with uncontrolled urbanisation*, lacking sufficient management systems for water, sewer and waste, provides hosts and breeding sites⁵⁻⁸
- *Increased travel and transport* between communities, countries and continents causes rapid exchange of dengue virus strains, as well as introduction of the vector to new places^{5,8}
- *Outdated or deteriorated epidemiological surveillance and control* systems have not managed to adapt to the new demographical trends, and thus lag behind in control of the disease⁷
- The *increased use of non-recyclable products* together with *insufficient garbage collection services* makes the amounts of breeding sites increase⁶⁻⁸

2.2. The disease

Manifestation of DENV infection may span from asymptomatic disease, through disease with mild, influenza-like, self-limiting symptoms, to severe life-threatening disease with hemorrhagic manifestations and shock. Thus, dengue is classified as either *dengue fever* (DF, also known as *classical dengue*), *dengue hemorrhagic fever* (DHF) or *dengue shock syndrome* (DSS)^{6,7}. Four serotypes of DENV have been isolated; serotypes 1, 2, 3 and 4 (DENV-1, DENV-2, etc.). Infection with one serotype gives lifelong immunity against the same serotype, whereas a secondary infection with another serotype may in fact exacerbate the disease. This is due to, among other things, a massive IgG antibody response with antibodies able to cross-react with, but not cross-neutralise other DENV strains. This facilitates the phagocytosis of the virus by monocytes and macrophages. However, as the non-neutralised DENV is able to proliferate within these cells, virus replication, and subsequently viremia, may actually be catalysed by the phagocytosis⁷. This phenomenon is known as antibody-dependent enhancement (ADE).

No specific antiviral treatment is available, but symptomatic and supportive treatment may drastically decrease the mortality. Nor are there any licensed vaccines, however, numerous candidate vaccines are in development. A vaccine needs to be effective against all four serotypes of the dengue virus to avoid the risk of inducing ADE^{6,9}.

2.3. Historical distribution of dengue

2.3.1. Early history of dengue

An epidemic of classical dengue was accurately clinically described for the first time in Philadelphia in 1789. However, clinical descriptions compatible with dengue exist from epidemics occurring centuries before in Egypt, Panama, Indonesia and Persia, among others⁷. The first written source of what is presumed to be dengue dates back to the Chinese Encyclopedia of Disease and Remedies from the third or fourth century AD¹⁰.

2.3.2. History of dengue in America

In America, DF has been present in large parts of the continent, as far north as Philadelphia and as far south as the Southern Cone. DF epidemics have tended to occur across the continent in cyclical patterns with years in between⁷. The second half of the twentieth century, however, has been dominated by a change both in the clinical and epidemiological picture of the disease. Mass troop transport during World War II led to intermixing of viral serotypes and spread of the mosquito *Aedes aegypti*^{7,11}. Co-circulation of several serotypes predisposes for the development of DHF, which was subsequently recognised as a clinical entity in South-East Asia in the mid-1950s⁷. Increasing travel and migration in the post-war years has contributed to the spread of the disease and its vector¹¹, which is now found in almost 100 countries across the tropical world⁸.

In America, however, Pan American Health Organisation (PAHO) programmes in the 1950s and 60s aimed at eradicating the *Ae. aegypti*, the common vector of yellow fever virus (YFV) and dengue virus (DENV), both belonging to the flavivirus family, helped control DF epidemics occurring across the continent⁶. The PAHO programme reportedly eradicated *Ae. aegypti* from more than 73% of the originally endemic areas¹¹. In the 1960s and 70s, however, vector eradication programmes were increasingly difficult to sustain, and deteriorated for a number of reasons^{6,11} (see 2.4.1). As *Ae. aegypti* is a highly antropophilic species, likely to thrive in urban areas where sanitary infrastructure is deficient, the urbanization boom of Latin America was accompanied by a rapid reinfestation with the species in numerous areas^{6,12}. In the late 1970s and in the 80s, the re-emergence of DF came to attention as a public health problem¹³. In 1997 the geographical distribution of *Ae. aegypti* appeared to be even wider than before the eradication programmes in the 1950s and 60s⁸. During the 1980s and 90s, DF epidemics again occurred in most Central American countries, Brazil and in the Southern Cone¹².

2.3.3. Dengue in Mexico

Mexico was one of the areas where DF was seemingly eradicated after PAHO eradication programmes. The country was assumed to be free of the disease from 1963¹³. In Mexico, outbreaks of DF were recorded in 1977 in the wake of a DENV-1 epidemic in Jamaica the same year¹¹. DENV-2 and DENV-4 were subsequently isolated in 1983¹⁴. In 1995, the last serotype, DENV-3, was recorded¹¹. In the same year, the first epidemic of DHF occurred in Mexico¹⁵. From the 1970s until now, parts of Mexico, along with large parts of Latin America, has become a hyperendemic region, meaning that several DENV serotypes are circulating at the same time, and that outbreaks of DF are occurring each year, as opposed to the historical pattern of sporadic epidemics occurring years apart¹¹.

2.4. Dengue prevention, surveillance and control programmes in America

2.4.1. Traditional approaches

Dengue surveillance systems consist in epidemiological and entomological surveillance components¹⁶. Traditionally, a problem has been that surveillance has been carried out by different departments without satisfactory integration and coordination, which again has impaired the efficacy of the surveillance⁸. Entomological surveillance has been based on indices made for the yellow fever eradication programme. Likewise, the control programmes being used were originally created for the yellow fever eradication work in the 1950s. These, basically, consisted in extensive use of insecticides, and visits by field workers to every household in a specific area at certain times of the year⁸. Both of these measures were very expensive, and proved to adapt poorly to the changing demographical trends, as urbanisation and population density increased. This occasioned the deterioration of the control

programmes in the 1960s and 70s, as they typically became unsustainable when resources were cut in periods free of outbreaks^{17,18}. Consequently, *Ae. aegypti* re-emerged in areas where it had earlier been eradicated, and emerged in new ones. The virus subsequently dispersed as well, causing ever more frequent epidemics, until the current hyperendemic state was reached^{2,12}.

2.4.2. Revision of strategies during the 1990s

Attempts to increase knowledge of the disease, the virus, the vector and breeding sites resulted in the promotion of a new dengue prevention and control strategy by PAHO and WHO in 1994 and 1995, respectively. They stressed that a “paradigm shift” was needed in the approaches to dengue prevention and control, and called for more integrated and comprehensive national dengue programmes, with more focus on the role of community participation and health promotion. This would mean integration of the traditional *vertical* (*top-down*) control programme with a *horizontal* programme. PAHO designated 10 components to be incorporated in future dengue programmes, the so-called *Decalogue*. These reflect the recommendations made by the WHO, PAHO and the US Centre for Disease Control and Prevention (CDC)^{19,8}.

The following overview of the Decalogue is adapted from Lloyd 2003⁸, and supplemented with PAHO sources.

According to the Decalogue, a dengue prevention, surveillance and control programme should include:

- I. Integrated epidemiological and entomological surveillance, comprising:
 - Active disease surveillance with sentinel clinics, monitoring of cases of fever of undiagnosed origin, confirmation of cases by laboratory tests, and ongoing analysis of trends of reported cases
 - Stratification of different geographical areas on the basis of risk factors²⁰
 - Formation of intersectorial dengue commissions at national, state, municipal and local levels
- II. Advocacy and implementation of intersectorial actions between health, environment, and education sectors, as well as others such as industry and commerce, tourism, legislation, and judiciary sectors, involving:
 - Health education²¹
 - Changes in legislation: e.g. fines for allowing breeding sites in homes, regulation of the use of tires, norms for recycling etc.²¹
- III. Effective community participation, including:
 - Involvement of local, social, cultural, financial and political components through activities such as meetings, contests and distribution of educational materials, thus facilitating an ongoing educational process among the population²⁰
 - Involving mass media, the private sector, schools, industries, enterprises, churches²¹
- IV. Environmental management, addressing basic services such as water supply, disposal of used water, solid waste management, and disposal of used tires
- V. Patient care within and outside of the health system, including:
 - Correct classification of suspected DF/DHF and correct case management
- VI. Case reporting (reports of clinical cases, confirmed cases, DHF cases and deaths due to DHF, circulating serotypes), with:
 - Prompt, reliable reporting of suspected and confirmed cases and deaths
 - Laboratory services and a reference laboratory for control

- VII. Incorporation of the subject of dengue and health into formal education systems, including:
 - Certification of teachers in health-related subjects
- VIII. Critical analysis of the use and function of insecticides, consisting in:
 - Evaluation of the effect of each type of chemical prior to its use
- IX. Formal health training of professionals and workers both in the medical and social sciences
- X. Emergency preparedness, establishing mechanisms, and plans to face outbreaks and epidemics

Thus, in the Decalogue we find a description of several preventive measures which WHO point out as the base for the prevention of dengue fever outbreaks. Preventive measures against dengue are basically a combination of vector control measures, health education and community strategies, as no vaccines are currently available⁴.

2.5. Architecture of the Mexican health care system

The Mexican National Health System (Spanish: Sistema Nacional de Salud, SNS) consists of several institutions existing in parallel. However, these cooperate extensively on various areas. Parts of the population have health insurance through two social security institutions known as the Mexican Social Security Institute (Spanish: Instituto Mexicano del Seguro Social, IMSS) and the State Employees' Social Security and Social Service Institute (Spanish: Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado, ISSSTE). IMSS and ISSSTE constitute large parts of the Mexican public health system, and each one has its own hospitals and health institutions attending employees of the private and the public sector, respectively²².

Some other institutions also offer health care services to smaller parts of the population, among these is the National System for Integral Family Development (Spanish: Sistema Nacional para el Desarrollo Integral de la Familia, DIF)²².

However, large parts of the population do not have social security through the IMSS or the ISSSTE, as they are not employed in companies or institutions cooperating with the aforementioned. The Mexican Ministry of Health (Spanish: Secretaría de Salud, SSA) offers health services to these uninsured parts of the population through separate public institutions²².

The SNS is hierarchically organised, with health care institutions of the SSA, IMSS, ISSSTE and others co-existing both on federal, state (state in this context meaning one of the federal entities of the Mexican federation), jurisdictional and local level. A *health jurisdiction* (Spanish: jurisdicción sanitaria) represents a geographically delimited administrative sub-entity of the state health care systems²³.

2.6. The Mexican state of Morelos

2.6.1. Geography of Morelos

2.6.1.1. Territory and topography

With a size of 4 941 square km²⁴, Morelos is the 3rd smallest of the Mexican federal entities, occupying only 0.25% of the mainland territory of Mexico²⁵. Morelos is situated to the south of Mexico City and the Distrito Federal (i.e. Federal District, DF), on the southern slope of the altiplano²⁴.

The territory of Morelos is on the border of the two physiographic regions of Sierra Madre del Sur and the so-called Transmexican Volcanic Belt (Spanish: Eje Neovolcánico, literally Neovolcanic Axis)^{25,26}. The latter is a range of volcanoes comprising the 5 500 m high

Popocatepetl²⁵, the crater of which lies where the three states of Morelos, Estado de Mexico and Puebla meet, at the north-eastern corner of Morelos²⁷.

The northern and eastern parts of the state are both counted to the Transmexican Volcanic Belt, although only the areas on the slopes of the Popocatepetl reach very high altitudes, in the county of Tetela del Volcán. The eastern parts of the state consist of an undulating landscape of altitudes about 1 250 m above sea level²⁷, in which the second-largest city in the state, Cuautla, is situated.

The western parts of the state belong to the Sierra Madre del Sur. In between the two mountainous ranges, Morelos largely consists of the basin Cuenca del Balsas (Balsas Basin), which comprises 87% of the state²⁸. The state capital Cuernavaca is situated in the north-west of the state on the border between the two regions²⁷.

2.6.1.2. Climate

Due to the large variations in altitude, there are also large climatic variations in the state of Morelos, with an annual mean temperature ranging from 26°C in the hottest regions to 0°C in the coldest²⁵. The coldest regions are in the north towards the Transmexican Volcanic Belt. 68% of the state is characterised as having a warm, sub-humid climate with a rainy season in summer, 19% as being temperate with a rainy season in summer²⁸. Some mean temperatures are shown below to illustrate the variations found. Jojutla is a town in the south-west of Morelos, Huitzilac a county to the north of Cuernavaca.

| Location | Altitude above sea level | Mean annual temperature | Mean annual precipitation |
|-------------------|--------------------------|-------------------------|---------------------------|
| Cuautla | 1 300 m | 21.5°C | 856.7 mm |
| Jojutla | 890 m | 24.5°C | 863.2 mm |
| Cuernavaca | 1 560 m | 20.7°C | 1 210.5 mm |
| Tetela del Volcán | 2 250 m | 16.4°C | 1 062.3 mm |
| Huitzilac | 2 550 m | 12.5°C | 1 542.4 mm |

Source: INEGI: *Anuario Estadístico de Morelos. Edición 2000*²⁸

Temperature, altitude and humidity are all factors that affect the distribution of *Ae. aegypti*. Accordingly, variations in dengue vector infestation and dengue incidences are great within Morelos; some counties are highly endemic whereas others report almost no cases (see 2.6.3.3).

2.6.1.3. Population

In 2007, the state had a population of 1 648 463²³, whereof 1 388 079 lived in localities of more than 2 500 inhabitants²⁵, corresponding to 84% of the population. Thus, Morelos is a state with a fairly high degree of urbanisation. The most densely populated areas are Cuernavaca and Cuautla with their suburbs and surroundings.

2.6.2. Structure of the health care systems in Morelos

At state government level, the highest ranking organ in Morelos is the state Ministry of Health (Spanish: Secretaría de Salud). In the state of Morelos, SSA provides its health care services through the Health Services of Morelos (Spanish: Servicios de Salud de Morelos, SSM). Also at state level, Morelos has representation of the two large social security systems IMSS and ISSSTE. The last institutions to form parts of the SNS in Morelos are the DIF, the Mexican Red Cross and the Ministry of National Defense (Spanish: Secretaría de la Defensa Nacional, SEDENA), which organises health services for the population enrolled in the Armed Forces. According to 2007 numbers, 37.2% of the population had social security rights

through IMSS, 8.3% through ISSSTE, and 0.7% through SEDENA. 53.7% of the population had no social security, and relied on SSM for provision of health care services²³.

Morelos is divided into three health jurisdictions. Jurisdiction I has administrative headquarters in Cuernavaca, jurisdiction II in Jojutla, and III in Cuautla. Each jurisdiction covers roughly one third of the state territory²³.

2.6.3. The epidemiology of dengue in Morelos

2.6.3.1. Before 2008

Morelos was one of the last Mexican states to register cases of dengue after the re-emergence of the disease on Mexican soil¹⁴, and for a long time it was considered a low-risk area for dengue transmission. In the period between 1978 and 2005 only one year was registered with an annual state-wide incidence above 500. However, in 2006, 2 835 cases were registered, including 410 DHF cases. Virological analyses this year showed that DENV-1, DENV-2 and DENV-3 were all circulating in the state, but not in the same areas, a situation which continued throughout 2007. In 2007 DENV-1 was causing the majority of cases across the state, but the number of cases did not reach the one of 2006*.

For the period 1980-2008, seven counties have been noted as more affected by dengue than elsewhere in the state. These counties include Cuernavaca and Cuautla, as well as counties in the conurbations around these cities: Temixco, Jiutepec, Emiliano Zapata and Ayala*.

2.6.3.2. The outbreak of 2008

In 2008, however, Morelos experienced the largest outbreak of DF fever in the history of the state. This year, Morelos had 16 963 probable cases of DF/DHF. 15 139 of these were finally classified as DF, and 1 824 of DHF*. Counting only laboratory confirmed cases, there were 5 943 confirmed cases of DF, and 2 175 of DHF, meaning the total number of confirmed dengue cases was 8 118. However, no fatal cases were reported. The overall incidence for DF throughout the year, in other words, was 361 per 100 000 for DF, 132 per 100 000 for DHF, and 492 per 100 000 for dengue as a whole²⁹.

The most affected counties were both part of the conurbated area around Cuernavaca: Temixco with 1 115 DF and 269 DHF cases, corresponding to annual incidences of 1 083 and 261 per 100 000; and Xochitepec with 446 DF and 122 DHF cases, corresponding to annual incidences of 776 and 212 per 100 000, respectively³⁰. Only two counties on the northern border of the state, corresponding to areas of higher altitude in the Transmexican Volcanic Belt, did not report cases³⁰.

Cases reported in Mexico as a whole included 28 015 DF cases, 7 588 DHF cases, giving a total number of dengue cases of 35 603²⁹. The country has a population of 106 682 518²⁵. This means that Morelos, accounting for roughly 1.5% of the population, accounted for 22.8% of the dengue cases reported in Mexico throughout the year. Mexico as a whole had a total incidence for DF and DHF of 33 per 100 000. Morelos was in the first place in Mexico both according to incidences and sheer numbers of DF and DHF³⁰.

2.6.3.3. Current situation – 2009

Until week 32 of 2009 the number of registered DF cases in Morelos had reached 343 and DHF cases 48³¹. The county of Emiliano Zapata, bordering with Cuernavaca, had the highest numbers with 77 DF and 8 DHF cases, corresponding to an incidence of 98 and 10 per 100 000 inhabitants, respectively, this far in 2009. Eight counties in the Transmexican Volcanic Belt, on the northern and eastern borders of the state, had reported no cases.

* Information from the SSM document Programa de Acción: Enfermedades Transmitidas por Vector y Zoonosis, Componente Dengue

2.6.3.4. Cases reported according to notifying institution

In Morelos, cases reported according to notifying institution were as follows in 2008:

| Institution | % of total DF cases reported | % of total DHF cases reported |
|-------------|------------------------------|-------------------------------|
| SSA | 54% | 70% |
| IMSS | 41% | 21% |
| ISSSTE | 4% | 9% |
| Others | 0,4% | 0% |

Source: SSM, *Anuario Estadístico 2008*³²

3. Materials and methods

3.1. Scope of this section

According to the guidelines for this paper given by the University of Oslo, a rather thorough overview of methodological considerations is given. References are given to relevant literature in order to expose the theoretical background for our choices.

3.2. Strategy

During this work, we have made use of several methodological approaches. Firstly, we conducted a literature search for background material. Secondly, we analysed relevant normative documents regulating the dengue prevention, surveillance and control programme in Morelos. Thereafter, interviews with key informants and direct observation were conducted. Analysis of the interviews was carried out. Information extracted from these was combined with written information from relevant sources to synthesise a picture of the workings of the dengue programme in Morelos, as well as experiences made during its implementation. Lastly, we have discussed our findings in the light of WHO/PAHO guidelines and published literature. Further details on each step in the process are given below.

3.3. Literature search

This work started with search of selected Internet databases for studies and reviews about dengue prevention and control programmes, with particular emphasis on Mexico and Latin America. Our search terms included free text terms as well as Medical Subject Heading (MeSH) terms. The terms included: “dengue”, “dengue hemorrhagic fever”, “dengue shock syndrome”, “surveillance”, “prevention and control” “vector control”, “Aedes”, “systematic review”, “meta analysis”, “laboratory procedures”, “diagnosis”, “Mexico”, “Morelos”, “America” among others. The searches were carried out in Scientific Electronic Library Online (SciELO), the United States National Library of Medicine and the National Institutes of Health Medical Database (PubMed) and Cochrane Library. In addition to this we searched internet sites from the Pan America Health Organisation (PAHO) and World Health Organization (WHO) for guidelines and recommendations regarding dengue surveillance and control. We have also searched for relevant documents on the Internet sites of the Mexican National Centre for Epidemiological Surveillance and Disease Control (Spanish: Centro Nacional de Vigilancia Epidemiológica y Control de Enfermedades, CENAVECE), the Mexican Ministry of Health (SSA), the Health Services of Morelos (SSM), the Mexican Institute for Statistics, Geography and Informatics (Instituto Nacional de Estadística, Geografía e Informática, INEGI) and the Inter-American Development Bank (IADB). We accepted results in Spanish and English.

We have not applied strict delimitation criteria, but prioritised reading systematic reviews as well as international guidelines for dengue prevention, surveillance and control. We also

consulted particular studies when they were of special interest or importance to our paper. These articles provided a comprehensive understanding of the key elements of a dengue prevention, surveillance and control programme, as well as of challenges that are often encountered by such programmes.

Our main reason for searching for and reading published literature, was to provide background for us to understand the dengue prevention, surveillance and control programme in Morelos, which was going to be the subject of our study.

3.4. Additional literature

During our stay at SSM in Cuernavaca, some additional written information and documents were also provided by employees of the SSM, including an internal working SSM document, outlining the current plan for dengue surveillance, prevention and control in Morelos (Programa de Acción: Enfermedades Transmitidas por Vector y Zoonosis, Componente Dengue). We have also looked up some specific articles during the writing of this paper, after our stay in Morelos, when we have found something particularly relevant to our work.

3.5. Document studies

We have reviewed official documents of the Mexican Ministry of Health (SSA) regulating routine epidemiological surveillance and control in Mexico, in particular those regarding dengue fever, thus establishing what current Mexican norms for the dengue surveillance, prevention and control programme are. These documents include the Official Mexican Norm for Epidemiological Surveillance (Norma Oficial Mexicana NOM-017-SSA2-1994, para la vigilancia epidemiológica), the Official Mexican Emergency Norm for the Epidemiological Surveillance, Prevention and Control of Vector Borne Diseases (Norma Oficial Mexicana de Emergencia NOM-EM-003-SSA2-2008, para la vigilancia epidemiológica, prevención y control de enfermedades transmitidas por vector), the Manual for Dengue Surveillance, Diagnostics, Prevention and Control (Manual para la Vigilancia, Diagnóstico, Prevención y Control del Dengue), the Guidelines for the Epidemiological Surveillance of Dengue Fever and Dengue Haemorrhagic Fever (Lineamientos para la Vigilancia Epidemiológica de Fiebre por Dengue y Fiebre Hemorrágica por Dengue), the Procedure for the Application of the New Algorithm of Dengue Fever and Dengue Haemorrhagic Fever Laboratory Diagnostics (Procedimiento para la Aplicación del Nuevo Algoritmo para Diagnóstico por Laboratorio de Fiebre por Dengue y Fiebre Hemorrágica por Dengue) and Control methods for the *Aedes aegypti* mosquito vector of the dengue virus in Mexico (Métodos de control de *Aedes aegypti* mosquito vector del virus del dengue en México). Sections 4 and 5 of this paper consist of an overview of these national norms and guidelines. As the dengue prevention, surveillance and control programme is extensively intertwined with the general Mexican system of epidemiological surveillance, the SINAVE, a description of the structure of this system is given in some detail.

3.6. Interviews

3.6.1. Selection of informants

We have interviewed a selection of persons with key positions in the dengue prevention, surveillance and control programme in the Mexican state of Morelos. During the interviews, we questioned the informants about the experiences and observations they have made during their work with the programme. The interviews were also meant to supply information about how, specifically, the programme is carried out in Morelos.

Thus, we interviewed the responsible for dengue surveillance in Morelos at the section of epidemiology, the responsible for entomological surveillance and vector control activities, and the responsible for health promotion work including community participation programmes. All are employed at the headquarters of the Health Services of Morelos (SSM) in Cuernavaca. We furthermore interviewed the coordinator of the Regional Vector Control Centre (Spanish: Centro Regional de Control de Vectores, CERECOVE) in Cuautla.

We have made the assumption that formalised, semi-structured interviews with these key persons would provide a reasonable amount of data to form a general impression of how the dengue programme is implemented and how it is currently functioning in Morelos. We have chosen this approach believing that a small number of interviews with higher ranking health workers, who we assumed to be reasonably well-informed about the activities of their respective divisions, would give a representative picture of the workings of the dengue programme. The informants were selected in order to cover the main areas that constitute dengue surveillance, prevention and control as we extrapolated them from the guidance documents. This non-random, *purposeful sampling* of informants was done to decrease the possibility of selection bias³³, thus achieving the most reliable and accurate information possible on our objectives. Regarding selection bias; as Malterud emphasises, qualitative data may actually be more valid when few informants are chosen, that have knowledge about the issue in question, as opposed to a random sample of informants that do not necessarily have thorough knowledge about the issue³³.

This consideration was made in order to save the effort of interviewing large number of first-line health workers. This might have provided other perspectives on the practical implementation of dengue prevention and control measures, but would undoubtedly be vastly more work-intensive, and impossible to carry through within the time frame we had at our disposal. Furthermore, we have made the consideration that it is interesting in its own right to hear the opinions of experienced public health workers at a higher administrative level; as these, assumedly, have experience and a knowledge base accumulated through work in this area to help them form these opinions. This may be information that is not available through other sources like manuals, guidelines or surveys, and may clarify and contribute to the information we already possess³⁴.

Sufficient background information – in our case provided by the literature and documents we had studied – was important both to guide the questioning and to minimise bias due to false interpretation³⁴, thus increasing the overall validity³³.

3.6.2. Interview circumstances

All interviews except one were carried out in the respective offices of the interviewees during their working hours. In our opinion this was a good option, as the interviews were related to their work. It was a setting where they were familiar to talk about the subjects in question, and where it was possible to sit undisturbed. The interview with the leader of the CERECOVE was of practical reasons carried out at her home. All interviews were conducted in Spanish. All quotes used in this paper have been translated by the authors. All interviews were recorded and transcribed for analysis, constituting all together a volume of approximately five hours, corresponding to a text body of 48 pages. Explicit consent was obtained on tape for using information provided in the interviews for this paper.

3.6.3. Interview design

Questions for the interviews were designed to elicit factual information on the actual implementation of the dengue programme in Morelos, as well as in order to inquire about the informants' opinions on it. Positive aspects, trends and developments were tentatively examined, as well as aspects of the programme that are not as well-functioning, and problems

encountered. In such settings, it is important to be aware of the pitfall of formulating questions that would confirm the assumption already possessed by the interviewer. To minimise this risk, the questions were prepared beforehand, and written down to secure nothing was forgotten during the interview. As described by Andersen³⁴, we tried to carry out the interviews as conversations, fitting questions and responses into the flow of themes as naturally as possible. Any intervention by part of the interviewer (e.g. questions asked or not asked) could potentially reveal opinions, prejudices or other implicit information being held by the interviewer. This could influence the answers, and thus potentially decrease the validity of the data material by³³, a phenomenon known as interviewer bias³⁵.

3.6.4. Interview analysis

The interview analysis was carried out using the transcribed material from the recordings.

According to Andersen³⁴, two kinds of statements are important to identify and separate from each other in the interview material. Firstly, some statements represent facts that could be established independently of what the informants say. Secondly, there are statements that actually convey considerations or assessments made by the informant.

Thus, descriptive information supplied by the informants about the programme as implemented in Morelos, and its current status, was summarised in a separate section along with information from written sources (section 6). Those aspects not described in, or deviating from, the dengue programme as described in the norms and guidelines are more thoroughly commented on. Aspects carried out as described in these documents are more briefly mentioned, as this is already summarised in sections 4 and 5 of this paper.

Secondly, based upon the interviews, we have tried to extract some important points made by the informants as to their considerations about how the dengue programme is implemented, should be, or should not be implemented in Morelos (section 7).

Direct quotes are included in the text where we consider them particularly illustrating.

3.7. Observation and participation

Supplementary information was gathered through observation in less formalised settings, including visits to Hermenegildo Galeana Health Care Centre in Cuautla, Axiochiapan County Hospital, the State Laboratory (Coordinación de Control Analítico, CCA) in Cuernavaca, the CERECOVE in Cuautla, and the State Ministry of Health (Secretaría de Salud)/SSM in Cuernavaca. We also participated in direct observation of field entomological work, including larval sampling and ovitrap revision, in the county of Yautepec, insecticide trials performed in Cuautla with the objective of evaluating efficacy on *Aedes aegypti*, and an information workshop at a primary school in the county of Yautepec.

4. SINAVE - the Mexican system of epidemiological surveillance

4.1. Structure

The Mexican systems for dengue surveillance are an integral part of the general national Mexican system of epidemiological surveillance. A description of this system is included, as it forms the base for understanding dengue surveillance in Mexico. The system of epidemiological surveillance in Mexico is referred to as SINAVE (Spanish: Sistema Nacional de Vigilancia Epidemiológica). SINAVE is hierarchically organized, as the rest of SNS, with four administrative levels: national (federal) level, state level, jurisdictional level and local level³⁶.

- The coordinating unit of SINAVE at the *federal level* is the National Committee of Epidemiological Surveillance (Spanish: Comité Nacional para la Vigilancia Epidemiológica, CONAVE). CONAVE is a permanent committee of the SSA, and

has representation from the organs that constitute the SNS, including SSA, IMSS and ISSSTE. Subunits of the IMSS and the ISSSTE co-exist with the institutions of the SSA at all administrative levels.

- At the *state level* epidemiological surveillance is handled by a State Committee of Epidemiological Surveillance (Spanish: Comité Estatal de Vigilancia Epidemiológica, CEVE).
- Mexican states are, as mentioned, in turn divided into health jurisdictions (Spanish: jurisdicciones). The *jurisdictional level* also has its own epidemiology committees.
- The *local level* refers to hospitals, health care centres and other institutions that have direct contact with the public. These institutions may belong to any of the branches of the SNS. They are all meant to have local institutional groups (Spanish: Grupos institucionales) handling and compiling epidemiological data.

At national, state as well as jurisdictional levels, epidemiology committees are referred to as Interinstitutional groups (Spanish: Grupos interinstitucionales), consisting of representatives of all branches that make up the SNS, including the institutions of the SSA, IMSS, ISSSTE, and others, depending on which institutions are represented on the administrative level in question³⁶.

4.2. Information system of SINAVE. Routine handling of epidemiological data

As the Mexican health care system consists of several health care providers existing in parallel, the major institutions of the SNS have created a common system for the handling of epidemiological data – the Unified Information System for Epidemiological Surveillance (Spanish: Sistema Único de Información para la Vigilancia Epidemiológica, SUIVE). Epidemiological data from the local level are passed on through SUIVE to the next administrative level using standardised forms. At the jurisdictional level, data about the disease panorama seen at the local level are compiled and analysed. Equally, epidemiological data are processed at state and national levels as they are passed on up through the hierarchy³⁶.

4.3. Levels of urgency for notification

SINAVE has established five levels of urgency for the notification of new cases: immediate, daily, weekly, monthly and annual notification³⁶.

- *Immediate notification* should follow if an outbreak – defined by SSA norms as two or more cases of any disease detected at the same time and place – is discovered. Official norms also list particular diseases meriting immediate notification upon the detection of a single case or death due to such disease. Concretely, immediate notification means that information about the case should be sent in the fastest way possible, passing through all administrative levels and reaching the national level of SINAVE within 24 hours. DHF is one of the diseases requiring immediate notification, along with, among others, *P. falciparum* malaria, yellow fever, rabies, influenza, meningococcal disease and childhood diseases preventable by vaccination.
- *Daily notification* applies to a small number of diseases listed in the SSA norms.
- *Weekly notification* is required for diseases of special epidemiological importance that, however, do not require as urgent attention. Classical, non-haemorrhagic DF is among the diseases listed by the SSA at this level of urgency, along with all other vector-borne diseases. Epidemiological statistics for last week are sent every Monday from each health institution at the local level. Within the end of the following week, this information should have passed through and been analysed at

all levels of the SINAVE, resulting in the publication every Friday of the Weekly Epidemiology Bulletin (Spanish: Boletín Semanal Epidemiología).

- *Monthly notification* is used to handle information from specialised subsystems of the SINAVE, designed to deal with diseases of special epidemiological importance. These subsystems will be discussed further below. One of these subsystems concerns DF and DHF.
- *Annual notification* means that each health care institution should compile a yearly statistic to be re-analysed at the next administrative level. This is in order to ensure that information passed on throughout the year has been correct.

4.4. Epidemiological case studies and outbreak studies

In addition to the routines for information flow mentioned above, SSA norms also require additional epidemiological information to be gathered under certain circumstances³⁶. If a case of certain diseases listed by the SSA (including DF and DHF) is detected, or in the case of an outbreak as defined above, the health care institution to report this should perform a so-called Epidemiological Case Study (Spanish: Estudio Epidemiológico de Caso) or Outbreak Study (Spanish: Estudio de Brote), respectively. These are standardised forms for information collection, designed by the SSA in order to provide additional data for the analysis of the epidemiological situation. They are discussed in the context of DF and DHF further below (see 5.2.2 and 5.2.3).

4.5. Classification of cases in SINAVE

Cases of disease subject to epidemiological surveillance by SINAVE are divided into *suspected, probable, confirmed, compatible* and *discarded* cases³⁶. These categories are more closely defined with regard to each disease in specialised manuals published by the SSA. The case definition criteria in the context of DF and DHF will be reviewed further below (see 5.2.1).

Notably, some of the case categories are designed to allow swift response to a possible epidemiological emergency. A *suspected* case may be of interest in the setting of an outbreak of disease and thus merit attention in the analysis of epidemiological data in order to implement control measures¹⁴. For the sake of a retrospective analysis of the epidemiological picture in an area over time, however, this case category is not included. Cases reported in the SINAVE as suspected or probable shall, according to the manual for the disease in question, be reclassified as confirmed or discarded by the epidemiological committees at an administrative level indicated in the manual. This final classification should take place after having followed the clinical course of the case. For a final diagnose and classification of some diseases, supplementary findings – either results from laboratory tests or other supplementary examinations – are required. DF and DHF, among others, both require laboratory findings in order to set the final diagnose in SINAVE.

4.6. Laboratories of SINAVE

SINAVE has its own network of laboratories organised under SSA for performing analyses to support epidemiological surveillance. This is called the National Network of Public Health Laboratories (Spanish: Red Nacional de Laboratorios de Salud Pública, RNLSP). The RNLSP is organised with laboratories at national, state and local level, with varying degrees of specialisation and competence³⁶.

- The reference laboratory at *national level* is the National Laboratory of Public Health (Spanish: Laboratorio Nacional de Salud Pública, LNSP) of the National Institute of Epidemiological Diagnostics and References (Spanish: Instituto Nacional de Diagnóstico y Referencia Epidemiológicos, INDRE).

- At *state level*, the laboratories are called State Laboratories of Public Health (Spanish: Laboratorio Estatal de Salud Pública, LESP).
- At the *local level*, laboratories are found at health institutions like health care centres and hospitals.

Some of the more specialised tests used in epidemiological surveillance are only to be performed in LESP or by other laboratories of similar competence approved by the SSA. This includes all tests used in the diagnostics of DF and DHF, among others. Furthermore, INDRE perform routine quality control of a given percentage of tests performed at the LESP. Routines for how to obtain, transport, perform and control tests are described in the SSA manuals for the relevant diseases that are subject to surveillance. These routines are established by INDRE.

4.7. Special subsystems of SINAVE

SINAVE has a number of so-called *special subsystems* (Spanish: Subsistema especial) for epidemiological surveillance, dealing with specific diseases. These specialised systems handle diseases of particularly high priority – including dengue – when the epidemiological situation is of special concern and requires more intensive surveillance as well as specific measures in order to prevent and control the disease in question. CONAVE, the national coordinating organ of the SINAVE, may establish such systems when they find it needed. Special subsystems are organised in the same hierarchic fashion as other SINAVE structures³⁶.

SINAVE special subsystems operate after manuals provided by the SSA. These manuals provide both background information as to why the disease in question is of such great public health concern that it merits an own subsystem, as well as concrete guidelines for the implementation of a multi-faceted public health programme to supervise and control the disease. These guidelines include specific methods and procedures for epidemiological surveillance, definitions of case classification criteria for epidemiological purposes (as mentioned in 4.5) laboratory procedures, guidelines for control and prevention measures, and guidelines for education and training of health workers participating in the programme³⁶.

Due to the deteriorating epidemiological situation for DF and DHF in Mexico, SINAVE has established a special subsystem concerning these disease entities. Dengue is also one of a few specific diseases listed in SSA norms where active screening of the population in areas of concern is to be performed, meaning an active approach in the first-line health services in order to detect new cases³⁶.

Notably, epidemiological data collected by the SINAVE special subsystems are handled by own information systems, and do not replace the routine systems of weekly notification. The information handling system used for the dengue special subsystem, the so-called Unified Information Platform (Spanish: Plataforma Única de Información), is treated below (see 5.2.2). Furthermore, the registry of causes of death (Spanish: Sistema Estadístico y Epidemiológico de las Defunciones, SEED) is considered a specialised subsystem of its own within the SINAVE, and thereby accounts for its own data system. Thus, epidemiological data in the SINAVE may be found in up to three different information systems³⁶: the SUIVE, the SEED, and the special subsystem data handling systems.

5. National guidelines for dengue prevention, surveillance and control

5.1. Components of the dengue prevention, surveillance and control programme

As described above (see 4.7), in accordance with the norms³⁶ for the establishment of SINAVE special subsystems, a manual for surveillance and control of dengue has been elaborated by the National Centre for Epidemiological Surveillance and Disease Control

(Spanish: Centro Nacional de Vigilancia Epidemiológica y Control de Enfermedades, CENAVECE), a subsidiary institution of the SSA. This manual adheres to an official Mexican norm regulating the prevention and control of vector-borne diseases³⁷, and proposes the following components to be integrated into the dengue control programme¹⁴:

- Epidemiological surveillance, consisting in case notification, as well as the establishment of dedicated so-called dengue monitoring clinics. Specific criteria for case classification are defined³⁸
- Adequate treatment of patients with DF/DHF
- Entomological surveillance, consisting in evaluation of *Ae. aegypti* infestation through measurement of traditional larval indices and evaluation of adult mosquito population through traditional methods of sampling (ovitrap, sampling of adults with human bait, sampling of mosquitos when resting)
- Dengue transmission risk assessment based on larval indices
- Vector control, including larval control through physical, chemical and biological methods, and control of adult mosquito population through spraying with insecticides
- Establishment of a community-based participatory control programme

5.2. Epidemiological surveillance

5.2.1. Operational case definitions of dengue

Case definition criteria for use in epidemiological surveillance have been established by the SSA in accordance with the SINAVE case categories mentioned above (see 4.5). These are explicitly designed to have a high degree of sensibility in a clinical setting, and thus detect most of the cases that come to medical attention³⁸. SINAVE uses the following case definitions for identification of DF, DHF and dengue shock syndrome (DSS) cases³⁸:

- Suspected DF case: Any person living or coming from a region of known dengue transmission who presents with a non-specific clinical picture of fever or viral infection
- Probable DF case: A suspected DF case, presenting with fever and two or more of the following: Headache, myalgia, arthralgia, rash or retroorbital pain. Children under 5 years need only fever to be considered a probable case
- Confirmed DF case: A probable DF case a) where recent DENV infection has been confirmed through laboratory techniques, or b) that coincides in time and place with another confirmed case, or c) where laboratory results are not available at the moment
- Probable DHF case: A probable DF case with one or more of the following criteria: signs of plasma leakage, capillary fragility, any kind of haemorrhagia, thrombocytopenia below 100×10^9 platelets/L or signs of haemoconcentration. Haemoconcentration is again defined as either an increase in haematocrit of 20% or more during the acute phase of the disease, a decrease in haematocrit of 20% or more after treatment, a rising tendency of the haematocrit in several consecutive blood samples, a haematocrit/haemoglobin ratio larger than 3.2, or hypoalbuminemia
- Confirmed DHF case: A probable DHF case with evidence of plasma leakage and either a) capillary fragility, or b) thrombocytopenia below 100×10^9 platelets/L. Plasma leakage must be confirmed by either a) clinical evidence of oedema, petechiae, ascites or pleural effusion b) laboratory evidence of haemoconcentration as mentioned above, or c) ultrasound evidence of perivisceral, intraperitoneal or intrathoracic effusion/X-ray evidence of ascites or pleural effusion. Capillary

fragility must be confirmed by either a positive tourniquet test from the third day of disease, or skin manifestations as petequiae, ecchymoses or haematomas

- Probable DSS case: A patient with probable DF or DHF with sudden onset of circulatory insufficiency (weak and fast pulse or cold extremities), or mental alteration (confusion), or a difference between systolic and diastolic blood pressure of under 20 mmHg, or an obvious state of deep shock
- Confirmed DSS case: A probable DSS case, where recent dengue infection is confirmed by laboratory techniques

Until 2008, case classifications included an additional variant of DF, namely DF with haemorrhagic manifestations. This has, however, been taken out in the newest revision of SSA guidelines.

5.2.2. Notification of DF/DHF cases

According to the SSA dengue manual and guidelines^{14,38}, the classification of *suspected* cases is only used during outbreaks, and these cases are used only on the local level, and not reported unless they are reclassified into another category. *Probable* cases of DF should, however, be reported weekly through SUIVE. Probable cases of DHF/DSS, or deaths from probable DHF/DSS, should be reported immediately, i.e. within 24 hours, as mentioned above^{14,38} (see 4.3).

At the jurisdictional level of SINAVE, a computerized system called the Unified Information Platform (Spanish: Plataforma Única de Información) has recently been introduced. This contains a Dengue Module (Spanish: Módulo de Dengue) for the use of the SINAVE subsystem for dengue. The jurisdictional authorities should make data regarding any dengue case, clinical as well as geographical, available in the Dengue Module as soon as they receive it³⁸.

Probable cases of DF or DHF, and deaths from probable DF or DHF, are both required by SINAVE to be followed up through an Epidemiological Case Study. In practice, this means that a standardised form for DF/DHF cases (Estudio Epidemiológico de Caso de Fiebre por Dengue y Fiebre Hemorrágica por Dengue) should be filled out and sent to the epidemiological unit at jurisdictional level immediately. The data explicitly asked to be collected on the form include³⁸:

- the patient's personal data
- a list of all the places the patient has visited in the last two weeks
- a checkbox-based survey of symptoms according to the case classification definitions given above, including sections for signs of capillary leakage and haemorrhagic manifestations
- date of symptom debut
- date of contact with health services
- any known results from haematological, serological or virological tests
- any additional observations of relevance

In the case of deaths from probable DHF, a copy of the patient record should also be sent to the epidemiological unit at jurisdictional level³⁸.

5.2.3. Notification of dengue outbreaks

If there is an outbreak of dengue fever as defined by SINAVE (two or more cases coinciding geographically and chronologically), a so-called Dengue Outbreak Study should be performed³⁸. This also is a standardised form (Estudio de Brote de Dengue). On this form, the following is asked to be filled out³⁸:

- starting date of outbreak
- information of previous outbreaks in the area, including number of cases and viral serotypes circulating
- a table of the distribution of cases, deaths and number of persons at risk in the population stratified for age and gender
- a table for listing of symptoms, and the number and percentage of cases presenting with each of these
- graphically represented timeline for probable and confirmed cases, cases of DF and DHF, respectively, number of samples taken and number of tests resulting positive
- an estimation of number of cases based on laboratory results

During outbreaks, the requirement of laboratory confirmation to diagnose DF is not applied as strictly as at other times, in accordance with the case classification definition. However, an estimation of the number of confirmed cases is performed. This estimate is derived by applying the percentage of laboratory positives out of all cases sampled, to the number of probable cases not sampled. The number of cases confirmed by laboratory and the number of estimated cases among the non-sampled probable cases are then summed to yield the official number of DF cases³⁸.

Outbreak studies should be started immediately and the form sent to the jurisdictional level. During the outbreak, the epidemiological committees or CEVEs should continually estimate the number of current cases on the grounds of data performed by the local level. These committees shall then assess the need for implementation of additional control measures³⁸.

5.2.4. Monitoring clinics

Since 2008, so-called *monitoring clinics* (Spanish: *clínicas de monitoreo*) have been another strategy included in the guidelines for dengue surveillance. This corresponds to SINAVE norms for dengue surveillance³⁷, which indicate that dengue cases should be detected in a particularly active way. Monitoring clinics, according to the guidelines, should be established during significant outbreaks of dengue, where jurisdictional or state epidemiological committees see fit. In practice, this means selecting a first line health care institution in an affected area, where a physician, designated by the committee, will be working solely with the investigation and identification of probable DF/DHF cases. The committee should take care to select a health institution that they find representative from an epidemiological point of view, including that it is used by population of all ages and both sexes. The physician should then take samples for laboratory diagnostics of *all* probable DF/DHF cases, and likewise fill in the Dengue Outbreak Study form in all cases. The goal of this strategy is to heighten the quality of diagnostics, delimiting DF from other diseases giving similar symptoms, and through the larger proportion of samples taken, to improve the virological surveillance³⁸.

5.2.5. Routines for laboratory diagnostics of DF/DHF

In times of low dengue transmission, there should be obtained blood samples for laboratory diagnostics from all probable DF cases, in times of dengue outbreaks this requirement is lowered to 30% of the probable cases. Notably, as mentioned above, the case classification definition used allows DF to be diagnosed on clinical grounds during an outbreak³⁸. Laboratory diagnostics are required to be performed in all probable DHF/DSS cases whether during outbreaks or not, as well as in cases of death due to DHF/DSS. In this case, blood or biopsies from liver, spleen, lungs or lymphatic glands may be used as test material¹⁴.

Since 2008, NS1 viral antigen ELISA has officially been the laboratory test of preference if samples are taken within five days of the onset of fever. NS1 dengue diagnostics are to be

performed at a state level laboratory (LESP). For virological surveillance, virus isolation should be performed on 10% of NS1 positive samples. If NS1 testing is negative, or the samples are taken 6 days or later after onset of fever, ELISA IgM should be performed. If this also results negative, IgG quantification should be performed. If this also turns out negative, differential diagnostics should be performed. If any of the tests prove positive, this is to be reported through the Unified Information Platform, and the case is considered confirmed. The NS1 test assays currently in use are the commercially available Platelia BioRad. The IgM and IgG ELISA assays used are the commercially available PanBio ELISA kits³⁹.

5.2.6. Management of detected DF/DHF cases

According to the SSA dengue manual, all patients with probable or confirmed DF should receive adequate information about the alarm symptoms indicating that the disease may be progressing to a more serious course, and be informed that they should contact a second-line health care institution if they experience any of these. Furthermore, the manual proposes that all probable DHF or DSS cases should be referred to a second or third line health care institution, i.e. hospitalised¹⁴. When the patient is hospitalised, haematological analyses are to be performed every 8-24 hours during the acute phase to observe if parameters are indicative of DHF or DSS. Hospitals are required to update the jurisdictional level of SINAVE about the progression of the disease, so that the information may be entered into the Unified Information Platform for analysis³⁸.

5.2.7. Self-evaluation scheme

SSA requires that all levels of SINAVE institutions perform monthly assessments of their coverage through a set of indicators, including percentage of the outbreaks have been adequately followed through an outbreak study, percentage of DHF cases notified within 24 hours, percentage of DHF cases where haematological parameters have been adequately followed, and last but not least, DHF case fatality rate³⁸.

5.2.8. Treatment

Treatment is out of the scope of this paper, but is given accordingly after current manuals¹⁴.

5.3. Entomological surveillance

5.3.1. Larval surveillance

The SSA dengue manual indicates that systematic vector surveillance should include studying dengue vectors in their larval phase in areas considered to be at risk. In the manual, it is claimed that a sampling of between 5 and 10% of premises in an area would give an adequate estimate of larval density. However, it is admitted that this degree of surveillance is impossible for practical purposes, taking into account that this would correspond to controlling hundreds of thousands of premises in the areas at risk. Therefore, the manual proposes that surveillance be concentrated in the zones where risk is thought to be highest through a systematic, random sampling of houses, covering at least 30% of this selected high-risk area. The goals of the larval surveillance are to estimate the degree of larval density, and to identify the mosquito species present in the area taxonomically. The latter is performed to control if new vectors (i.e. *Aedes albopictus*) are appearing in an area¹⁴.

Larval surveillance data are registered on standardised forms for each premise, including the following¹⁴:

- Number of containers on the premise that could potentially accumulate water
- Number of containers presently containing water
- Number of containers containing *Ae. aegypti* larvae
- Number of containers containing *Ae. aegypti* pupae

The data from the larval studies in an area are again concentrated on standardised forms, to yield the traditional *Stegomyia* indices House Index (HI, defined as the percentage of houses where containers positive for *Ae. aegypti* larvae were found), Container Index (CI, defined as the percentage of controlled containers that were positive for larvae) and Breteau Index (BI, defined as the number of positive containers per 100 houses), as well a Pupal Index (Spanish: Índice de Pupas, IP, defined as the number of containers with pupae divided by the number of containers with larvae). The manual claims that the Pupal Index is an estimation of the fraction of containers that will eventually produce adult mosquitos¹⁴.

Positive containers found during the larval studies should also be classified. They are classified as either *outdoor* or *indoor* containers, and furthermore if they are *eliminable* (such as smaller plastic containers), *controllable* (e.g. buckets, flower pots) or *controllable through larvicide application* (e.g. water tanks, wells, tires, barrels used for water storage). Classification is done in order to analyse the productivity of different container types in the area, identifying those containers that are *most often positive* and *most likely to be colonised*, as well as those with the *greatest productivity*. The data from this analysis should be taken into account when considering different strategies of larval control measures (application of larvicide or measures to eliminate containers) for an area¹⁴.

The larval studies should, according to the SSA guidelines, be carried out on a regular basis in endemic dengue areas, and on a periodic basis in areas that may be potentially colonised by *Aedes* species. They should also be carried out before and after larval control measures, in order to assess the effect of the intervention¹⁴.

5.3.2. Surveillance of adult mosquito population

The SSA dengue manual proposes three different strategies for entomological surveillance of adult mosquitos. These include oviposition trap (ovitrap) sampling, sampling with human bait (exposing extremities of a person to mosquito bites and capturing them as they bite) and sampling of mosquitos when they are resting in or outside a house. It includes detailed practical information on how to construct ovitraps, and also how to perform sampling through capturing mosquitos with a suction device, both using human bait, as well as through searching for resting mosquitos on the premise to be surveyed. However, as both direct sampling methods of adult mosquitos expose the persons performing the survey to mosquito bites, and thus imply a risk of dengue virus transmission, it is specified that these methods should not be used in endemic areas¹⁴.

The ovitraps described are basically black 1-litre buckets filled with water, with a spatula covered in light-colored filter paper descended into the water. These are ideally to be placed in pairs, indoors and outdoors on the premises selected to be surveyed in the area in question. The ovitraps should then be revised approximately weekly, quantifying the number of *Aedes spp.* eggs that have been deposited on the paper in the meantime. The ovitrap is then washed, and a new paper provided for oviposition. Data from the area surveyed should be compiled to yield the following indicators – *percentage of positive premises*, *mean number of eggs per ovitrap*, and *percentage of positive indoor and outdoor ovitraps*¹⁴.

Using human bait for direct adult mosquito sampling, the indicators to be inferred from the data collected are an *index of mosquito bites per person per hour* and an estimation of the hours of greatest mosquito feeding activity¹⁴.

When searching for and collecting mosquitos resting on the premises, compilation of data are meant to yield a *mean number of female mosquitos per premise*, as well as a *percentage of mosquitos caught indoors and outdoors* (called *endophilia* and *exophilia*, respectively)¹⁴.

5.3.3. Estimation of dengue transmission risk

The SSA dengue manual claims that *dengue transmission risk* in the area that has been surveyed may be estimated from the HI, CI and BI¹⁴. It establishes so-called operational control levels when for larval control, based on the mentioned indices. The risk levels are defined as *optimal* (with a HI < 1, CI < 0.5 and BI of 1–4.9), *good* (HI 1-4.9, CI 0.5-1.9 or BI 5-9.9), *alarm* (HI 5-9.9, CI 2-4.9 or BI 10-14.9) and *emergency* (HI > 9.9, CI > 4.9 or BI > 14.9)¹⁴. Larval control measures are addressed below (see 5.4.2).

5.4. Vector control measures

5.4.1. Types of vector control measures

The SSA dengue manual describes some top-down (meaning carried out by public health workers without active participation of the population) vector control measures to be performed by health workers at the jurisdictional level, basically divided into:

- Physical control efforts
- Chemical control efforts
- Biological control efforts

All three kinds of measures apply to larval control, for control of the adult mosquito population only chemical measures apply¹⁴.

5.4.2. Larval control

5.4.2.1. Physical larval control measures

Physical larval control measures include the elimination and control of containers on premises inspected. Elimination means, basically, asking for permission to dispose of those containers that are of no use to the proprietor of the premises. Control means covering, perforating or washing containers, as well as turning them with the opening down or placing them under roof, all to avoid the accumulation of water¹⁴.

5.4.2.2. Chemical larval control measures

Chemical larval control measures may be implemented in containers that cannot be eliminated or controlled through physical measures. Such containers may include wells, water tanks, barrels used for water storage, cisterns or other similar installations that are of use and where accumulation of water over longer periods is inevitable. Chemical larval control is carried out through the application of the larvicide temephos, which, when correctly used, will keep containers free of larvae for 60-90 days¹⁴. Dosages are given for granulates and mixtures, and the use of ready made bags of specified doses for rapid administration in different types of containers is advocated. Specific techniques are also described regarding how to apply temephos in containers where this may be technically difficult (e.g. wells). Temephos may also be used in water for human consumption. Larvicide treatment should be repeated in accordance with the indicated period of effect of the product, or more often if entomological indices measured are not satisfying, corresponding to the *alarm* and *emergency* operational control levels mentioned above¹⁴.

5.4.2.3. *Biological larval control measures*

Biological control measures listed include keeping larvivorous fish in containers that would otherwise be applicable for chemical control. The application of *Bacillus thuringiensis* – a bacterium that lives parasitically on mosquito larvae, thus killing them – is mentioned, but not recommended¹⁴.

5.4.2.4. *Duties of the larval control workers*

For all forms of control, the manual emphasizes that larval control workers must inform the proprietors of the premises about the importance of control efforts, in order to make them understand the risk of disease if measures are not carried out properly¹⁴.

Lastly, the larval control workers must register their activities on standardised forms, including the number of houses visited, treated and not treated, and the number of houses where they for some reason could not enter. They should also make remarks about any houses that were scheduled for treatment but not followed up. Forms of control measures carried out should be described, including the number of containers eliminated and controlled, and the volume of insecticide used. They should also make an assessment of what the main problem is in the area regarding container types, and a general description of the neighbourhood in question¹⁴.

5.4.3. *Control of the adult mosquito population*

5.4.3.1. *Indications for adult mosquito control measures*

According to the SSA dengue manual, adult mosquito population control measures is reserved primarily for controlling vectors in a given area in the case of a dengue outbreak. This is aimed at eliminating the vectors that are presumably already carrying the virus, thus inhibiting the transmission to yet not-infected individuals in the area¹⁴. However, it is noted that the effect of spraying is short-lived, with a reduction in infestation of only 2-4 weeks, depending on whether larval control measures are being controlled at the same time⁴⁰.

5.4.3.2. *Mode of operation*

The SSA dengue manual specifies how control of the adult mosquito population is carried out through spraying with insecticides aimed at adult mosquitos (adulticides). This may be done through so-called thermal fogging (vaporization of the insecticide through heating or through so-called ultra low volume (ULV) spraying, where the insecticide is aerosolised through a special apparatus without heating. Both techniques may be used on a small scale, using portable devices carried as a backpack, whereas the ULV technique may be used also on a larger scale, with spraying equipment mounted on pickups, boats or even airplanes¹⁴.

Due to the efficiency of large-scale spraying in terms of areas covered, one pickup-mounted device may cover up to 80 hectares per day, the SSA dengue manual primarily advocates the use of this form of spraying, reserving the methods using portable equipment for areas and houses the heavier equipment cannot reach. Detailed technical information on how to perform the spraying is given for all methods. Whatever the method, application of adulticides should be carried out at the time when the targeted mosquito is most active and thus likely to be out in the open, i.e. at dusk or dawn for *Aedes spp*¹⁴.

5.4.3.3. *Choice of adulticides*

Until 2008, SSA norms recommended the use of specific substances in the pyrethroid and organophosphate groups⁴⁰. The recommendations were changed, however, after at 2006 World Health Organization (WHO) inspection of the Mexican dengue control programme. Now, no

specific substances are mentioned particularly in the norm, but a general recommendation is made that the insecticides used must be currently approved by relevant international organisations, comply with a range of environmental norms, and have sound scientific proof of their effect³⁷. However, in February 2009 SSA issued a separate manual, Control methods for the *Aedes aegypti* mosquito vector of the dengue virus in Mexico (Spanish: Métodos de control de *Aedes aegypti* mosquito vector del virus del dengue en México⁴¹, short: SSA *Ae. aegypti* control manual) for the use of insecticides, advocating the use of the second generation pyrethroid d-phenothrin combined with the oxidase inhibitor piperonyl butoxide for large-scale spraying. In this manual it is claimed that phenothrin has proved great efficacy when used against *Ae. aegypti*. In the case of vector resistance against pyrethroids, the organophosphate chlorpyrifos-ethyl is recommended. For indoor residual spraying, the manual recommends the use of either the fourth generation pyrethroids deltamethrin, bifenthrin, lambda-cyhalothrin, cyfluthrin or the carbamate bendiocarb. SSA has also issued a summons for insecticide manufacturers⁴², specifying that in order for SSA to approve any insecticide for use in the public health sector, information must be provided proving that the insecticide in fact complies with the demands set forth in the new norms³⁷. SSA has also issued a list of insecticides approved for 2009⁴³, which is identical to the ones mentioned in the SSA *Ae. aegypti* control manual.

5.5. Patio Limpio – community-based participatory vector control efforts

5.5.1. Objectives of the Patio Limpio programme

The SSA dengue manual includes a section with guidelines for establishing a community-based participatory programme. This is called “Clean Backyard and Care of Stored Water” (Spanish: “Patio Limpio y Cuidado del Agua Almacenada”, short: Patio Limpio). It is, according to the guidelines, intended as an educational programme, in order to identify and change the habits of the population which lead to the proliferation of the dengue vector. Specific basic actions that are to be promoted are listed, including¹⁴:

- Keeping their premises tidy, with all containers liable to accumulate water under roof or turned with the opening down
- Keeping their premises free of larvae
- Cutting bushes and grass
- Washing and brushing containers used to store water every week, including drinking cups for domestic animals
- Keeping fish in containers used to store water for human consumption

5.5.2. Phases of the Patio Limpio programme

5.5.2.1. Role of the promoter

The Patio Limpio programme should be implemented by so-called *promoters* (Spanish: promotores), dedicated persons that are responsible for starting and following up programme activities at a local level. Programme guidelines describe four programme phases with different activities to be carried out by the promoter¹⁴.

5.5.2.2. Phase 1

The promoter should make a detailed sketch of the area where the programme is to be carried out, noting number of households and inhabitants in the area, number of dengue cases during the last two years, and drawing in any known frequently positive breeding sites. Furthermore, locations where people are likely to congregate should be drawn in, as well as any risk areas for mosquito proliferation, including areas with sporadic water supply or

garbage collection, stables, cementarys, abandoned houses and sewer canals. A main message to be promoted should be chosen, addressing the most urgent problem areas in the community (i.e. in order to focus on the breeding sites that cause the most vector proliferation in the area)¹⁴.

The promoter should also analyse the community itself, identifying what social resources are present in the population, and if any special considerations should be made when choosing educational strategies. The SSA dengue manual refers to specialised documents to be consulted when approaching e.g. indigenous communities¹⁴. A detailed description of these strategies is out of the scope of this paper.

The promoter should then make contact with leaders of local social groups as a first step in approaching the community. These leaders may be local health workers, teachers, religious leaders, or other formal or informal leaders identified by the promoter. Time and place should then be set together with these persons on which the respective groups should be addressed through a so-called *community workshop* (Spanish: taller comunitario), which constitutes phase 2 of the programme¹⁴.

5.5.2.3. Phase 2

During a 45-minute community workshop, the promoter should explain what actions the Patio Limpio programme consists in (as listed in 5.5.1), and also what the advantages of dengue prevention work are. A list of points to emphasise proposed in the SSA dengue manual includes both the avoidance of the illness itself, as well as additional effects like having nicer and cleaner surroundings where one lives, having more space to relax and for the children to play, not having to spend money on health care if one avoids disease, avoiding accidents due to discarded sharp objects stored in the backyard, eliminating hiding places for other vermins like scorpions, and the positivity of having a common project for the family. The promoter should also assess the level of knowledge about dengue in the group. Towards the end of the workshop, (s)he should propose that the group revise the backyard of one of the persons attending, pointing out breeding sites and demonstrating adequate control measures, as well as commenting on the cleanliness of the premises in general. Positive feedback should be given wherever the owner of the premises implements correct measures. Lastly, the promoter should register the names and addresses of those present, and ask for volunteers to help carry out the dengue control work among the members of the group. These volunteers are known as *activators* (Spanish: activadores de manzana, literally “city block activators”)¹⁴.

5.5.2.4. Phase 3

In the third phase, the actual implementation of control measures is started up. During a second meeting a week after the workshop, the activators are officially appointed and presented to the group, and should subsequently receive the relevant information and training needed to carry out dengue control work among their peers. The promoter should also present how the vector situation is in the area, mentioning the entomological indices, and explain the need to lower these in order to minimize risk of illness for the community. Goals should be set for the vector control work to be carried out by the group, including the activities of the activators, to be carried out in phase 4. Follow-up meetings should be scheduled with the activators, during which their work is to be supervised and information on the vector situation in the area collected¹⁴.

5.5.2.5. Phase 4

The fourth phase of the Patio Limpio programme is the monitoring phase, where the activators, equipped with official identification from the health jurisdiction, are to carry out their tasks among their neighbours in the community. They should ask for permission to carry

out larval studies on the premises belonging to members of the social group (registered by the promoter during the community workshop) in the area they are assigned to. The revision of the backyard should be done together with the homeowner. If breeding sites are found, the activator should remind the owner of the goals set during the start-up meeting, and encourage him/her to ensure that their premises are free of mosquito larvae. Information about the control measures to be carried out (as described in 5.5.1) should be given. The SSA dengue manual also suggests that the activators should point out the responsibility of the individual homeowner towards the group, by telling them that having a dirty backyard jeopardises the health of others. Activators are also asked to alert promoters, local leaders in their groups (as mentioned under phase 1) or other local health authorities if they observe or hear about anyone presenting with febrile illness¹⁴.

Larval study data are collected by the promoters from the activators on a monthly basis, and used to monitor the entomological situation in the area. If entomological indices are not satisfyingly controlled, promoters should consider the need of repeating the actions carried out in phase 3, including training of activators and address the group in question to reassess their goals¹⁴.

The local group leaders identified by the promoter in the introductory phase of the programme also play a role during the monitoring phase. Promoters should try to use the social groups to spread information on dengue control work. Local leaders may also aid the promoters by helping appoint additional persons, so-called *facilitators* (Spanish: *facilitadores*), that should also receive due information and training from the promoter. These facilitators should then also assist in the information work, e.g. organising information meetings on vector control work, and spreading information among friends, colleagues and others in general. Local leaders should also be kept informed by the activators on the work they do among their peers in their respective areas. They also may assist the promoters in assigning what houses should be inspected by each activator, and in collecting the larval survey information from the activators¹⁴.

6. The dengue control programme as implemented in Morelos

6.1. Sources of information

In this section, we have tried to extract facts provided through interviews to synthesise a picture of the *modus operandi* of the dengue programme in Morelos. Information from the interviews is combined with information from the SSM strategic document “Action Programme: Vector Borne Diseases and Zoonoses, Dengue Component” (Spanish: “Programa de Acción: Enfermedades Transmitidas por Vector Zoonosis, Componente Dengue”, short: SSM Action Programme), which was published in January 2009.

The interview material used consists of information supplied by our four key informants in a formalised interview setting. These informants are, respectively, the state dengue coordinator at the SSM section of epidemiology, Dr. Nora Bello Martínez, the SSM state coordinator of vector issues, the biologist Mr. Alejandro Villegas Trejo, the leader of the Regional Vector Control Centre (CERECOVE) in Cuautla, MSc Mrs. Mariana Irina González Fernández, and the leader of the SSM section for health promotion, Dr. Eduardo Sesma Medrano. Other informants have helped us obtain background information on various areas. However, material from these conversations and interviews are not included here, they are not cited or quoted. Only information documented on tape and subsequently transcribed is included here, with the exception of a few first-hand observations made by the authors. These are pointed out especially. All other information is provided by the aforementioned sources.

6.2. Epidemiological surveillance of dengue in Morelos

6.2.1. Routines for notification and laboratory diagnostics

The SSM Action Programme, when describing epidemiological surveillance measures to be taken for dengue, refers to official Mexican norms³⁶ and the SSA manual for dengue¹⁴, as well as the 2008 guidelines³⁸, for a detailed description of how routines are to be carried out. According to how the state dengue coordinator at the SSM section of epidemiology, Dr. Nora Bello Martínez, describes the routines for the notification of DF and DHF cases, they are implemented largely as provided in these documents. This applies to reports through SUIVE, epidemiological and outbreak studies, as well as the routines for laboratory diagnostics. Samples for dengue diagnostics are sent to the LESP in Cuernavaca, which is known as Coordinación de Control Analítico (CCA). On the implementation of the notification routines, she comments: “We sort of have an obsession for getting the forms in on time, quickly, but that is the only way to get to know what is really going on.”

6.2.2. Registration of data in the Unified Information Platform

Since 2008, all probable dengue cases are also registered, on a daily basis, in the Dengue Module of the Unified Information Platform at the jurisdiccional level, Dr. Bello Martínez explains. This dengue module was implemented as a prototype in Morelos that year, and has since been extended to cover the entire republic. All data from the epidemiological study are registered, and the case in question is marked graphically on a map integrated in the module. Laboratory results are registered automatically by the CCA in the platform, and are then instantly available to the epidemiologists at jurisdiction and state level, says Dr. Bello Martínez. This is also one of the goals for epidemiological surveillance set forth in the SSM Action Programme. The status of the patient is changed to confirmed or discarded according to the test result. The CCA also sends daily archives per e-mail directly to the section for epidemiology in order for them to cross-check that no data are lost, according to Dr. Bello Martínez.

6.2.3. Use and analysis of data in the Unified Information Platform

The data in the platform are used both for the follow-up of individual cases and for compiling statistics, Dr. Bello Martínez explains. Dengue information bulletins are made weekly at state level, and circulated in the SSM. These contain a range of statistical data, including the number of probable and confirmed cases of DF and DHF per county and jurisdiction, a ranking of counties according to number of cases, a breakdown of the detected cases according to notifying institution (SSM, IMSS, ISSSTE, SEDENA or other). A graph is also included in order to visually illustrate the development in the epidemiological situation compared to last year, Dr. Bello Martínez shows us. A so-called endemic channel, i.e. an area where the number of dengue cases is defined as normal according to seasonal variations, is used to distinguish seasonal increases from outbreaks. This is commented upon by Dr. Sesma Medrano of the Health promotion sector.

6.2.4. Lacking registration of cases from private physicians

With regard to the number of cases by institution, Dr. Bello Martínez remarks that almost no cases of DF or DHF are ever reported by general practitioners or health institutions in the private sector: “We have a blind spot. That is the private physicians.” To remedy this, she describes, they have an agreement with the counties that they should notify whenever they hear about a dengue case, even if patient does not seek medical attention. “[T]he private physicians treat a patient, and we do not hear anything. Then, how are we going to know if they are treated, and if the contacts are treated?” If they do hear about such a case, she says,

“we notify the jurisdiction, and they go to [fumigate] even though SSM did not detect the case.”

6.2.5. Individual follow-up of cases

Individual follow-up means that *all* patients should be visited at home, after they have been detected. This should be done by workers from the epidemiological section at jurisdictional level, Dr. Bello Martínez explains. This goal is also mentioned in the SSM Action Programme. During this visit the status of the premises regarding *Ae. aegypti* breeding sites should be assessed, says Dr. Bello Martínez, and if necessary, information should be given on how to improve conditions. The health workers should also confirm if larval control workers have visited the premises. Furthermore, they should ask if any of the patient’s contacts in the family and vicinity have experienced symptoms of DF. If they have, these should also be visited, in order to check if these may also be dengue cases, and to inspect the premises where the contacts live. Inspectors will also visit the houses of contacts and neighbours to assess if the patient in question may have been infected during a visit there, or if the breeding site is actually on the neighbouring premises, even though the contacts report no symptoms. “Sometimes the patient tells us: ‘oh no, I’ve got everything nice and tidy, but my neighbour lives in a pigsty’,” says Dr. Bello Martínez. “Then you show up there, and that is where the breeding site is.” The SSM epidemiological section at state level also supervises that the jurisdiction carries out these inspections. This is done through random control visits on premises reportedly inspected by the jurisdictions, she explains.

6.2.6. Agreements with neighbouring states on the exchange of information

SSM has made agreements with the health authorities of neighbouring states Puebla and Guerrero regarding the exchange of information about dengue cases and outbreaks in the border areas. This happens outside the formal SINAVE channels, i.e. outbreaks are notified by telephone directly to the health authorities of the state in question: “The counties bordering with Guerrero are [Tlaquiltenango, Coatlán del Rio,] Amacuzac and Puente de Ixtla. If I had five patients in Puente de Ixtla this week, I would run to call [Guerrero] and say, ‘You know what? I’ve got five cases just besides you’,” says Dr. Bello Martínez. Dengue cases in counties sharing border with the mentioned states are reported to these each week, and vice versa. These conventions have been agreed upon as there is a lot of traffic across the state borders. The Guerrero-Morelos border areas have historically been especially tightly intertwined with regard to the epidemiological situation, Dr. Bello Martínez explains, and the SSM state section for epidemiology pays special attention to these areas. “We have a drawback, so to speak,” she says, “in that people are moving around a lot. [...] For example, a lot of people live in Cuautla and work here in Cuernavaca, they come and go every day, and many people go to Guerrero. [They could get infected in Guerrero], and tomorrow we have another serotype of the virus here.”

6.2.7. Joint assessment of the epidemiological situation on state level

Dr. Bello Martínez and the SSM state coordinator of vector issues, biologist Mr. Alejandro Villegas Trejo explain that a group consisting of the leaders of each section involved in the dengue surveillance and control work, as well as the director of public health services and representatives from affected counties, convenes every two weeks to discuss the dengue situation in the state and assess the measures currently implemented. All counties in the state are invited to participate in these meetings. “And all should follow up on this invitation,” says dr. Bello Martínez, “but generally, only the same few attend.” Nevertheless, she says, these include some of the counties most severely affected by DF, including Cuernavaca, Cuautla, Temixco and Emiliano Zapata.

6.2.8. Assessment of the epidemiological situation during outbreaks

Mr. Villegas Trejo explains that during outbreaks the group of leaders at state level meets more frequently, even daily. A decision to make additional control measures at these times may be made by the group, Dr. Bello Martínez states. The SSA manual definition of an outbreak, being two cases, is applied. However, Dr. Bello Martínez tells us, dengue monitoring clinics, as described in the manual, are not organised during outbreaks, nor are other forms of case detection besides routine epidemiological surveillance. “There is no way to detect the patient if he does not seek medical attention. You cannot go from house to house looking for febrile patients.”

6.3. Entomological surveillance and vector control in Morelos

6.3.1. Objectives, organisation, resources and priorities of the vector control sector

6.3.1.1. Goals for entomological surveillance

The goals set forth in the SSM Action Programme for entomological surveillance, include monitoring the situation in 39 specified, priority locations, and any others specified by the CEVE. The number of such locations is now about 70, according to Mr. Villegas Trejo. Monitoring should be performed before and after any vector control measures are carried out. It should also include, the SSM Action Programme explicitly states, use of ovitraps in selected sentinel locations.

6.3.1.2. Organisation

Mr. Villegas Trejo explains that each of the jurisdictions has its own larval control brigades, brigades that perform indoor spraying with portable equipment, and brigades that do pickup-based large scale spraying, respectively. The larval control brigades have two functions, both performing larval surveys for calculation of entomological indices, and performing larval control measures. At the time of the interview, on the 31st of July 2009, SSM has about 300 full-time employees and another 200 temporarily hired workers working in vector surveillance and control, Mr. Villegas Trejo tells us.

6.3.1.3. Main focus

In the SSM Action Programme, the elimination of *Ae. aegypti* breeding sites through community participation is described as the priority measure of larval control. This is a joint responsibility of the health education sector and the vector control sector. The control work of the larval control brigades, which pertain to the latter sector, should consist both in giving advice on breeding site elimination and distributing temephos for non-eliminable breeding sites.

6.3.1.4. Classification of geographical areas according to priority

Larval control measures, the SSM Action Programme states, should have widespread coverage, however, the state is divided into areas of two so-called *strata* (Spanish: estrato) according to priority, in order to guide the use of resources to cover at least the areas of higher epidemiological risks. Stratum 1, consisting of the areas of greater priority, consists of 39 locations in 19 counties. This includes, notably, a lot of localities in the urbanized zones around Cuernavaca, Jojutla and Cuautla. The estimated number of houses to cover in this stratum is 393 171, according to the SSM Action Programme, corresponding to a population of 1 430 609 inhabitants. Stratum 2 consists of 35 locations in 16 counties, estimated to correspond to 38 965 houses, or a population of 149 220.

According to Mr. Villegas Trejo, stratum 2 generally corresponds to areas of more rural or semi-urban character. As a commentary to this, he tells us: “If you ask me if I can demonstrate precisely that there is less dengue, well of course I can. If we have a smaller population, there will be fewer cases. Ethically, each individual is important. However, in public health you do not see individuals, you see masses. You do protective work where a thousand people are going to die, not where five are going to die, even if all individuals, ethically speaking, are important. Thus, [stratum 2 locations] are where the population is small, although we even have had outbreaks there, but these have only resulted in five, maybe ten cases.” He emphasises that throughout the state epidemiological surveillance is performed, and clinical health care services equally offered, and that the division into strata only applies to public health measures such as entomological control.

Furthermore, areas where vector control measures are to be carried out are also determined through analysis of entomological indices. “What we have to do is good surveillance of the vector, and where we have ‘red lights’, that is where we have to invest the money. Then we will have sufficient resources,” says Mr. Villegas Trejo. “We do not have resources for all areas, if we try to do everything everywhere, resources will not suffice.”

6.3.2. Larval control brigades

6.3.2.1. Level of activity

The SSM Action Programme states that two visits by the larval control brigades were planned in the period from January to March 2009 for each house in stratum 1, and another 4 through the rest of the year. According to the programme, presuming that a brigade of six could cover 25 houses per day, this would depend on 500 additional larval control workers to be hired for the first three months and 400 for the last nine. As Mr. Villegas Trejo explains, this is not in accordance with the current crew situation. Thus, the larval control brigades will not be able to cover the areas in question with such a high frequency, but rather pass by about every three months. This is, as he describes, not an optimal situation, but he assesses the larval control situation to be satisfactory. Also, the epidemiological situation in 2009, with a relatively low number of cases to follow up with fumigation compared to last year, has permitted that personnel from fumigation brigades may aid the larval control workers in periods when spraying work is scarce.

6.3.2.2. Entomological surveillance through larval indices

*6.3.2.2.1. Use of the classical *Stegomyia* indices*

As mentioned, a key task of the larval control brigades is to gather entomological data in order to compile larval indices as described in the SSA dengue manual. Mr. Villegas Trejo confirms that the entomological indices in use are the classical *Stegomyia* indices HI, CI and BI. He maintains that the indices, as used in Morelos, are useful for estimating vector density. Operational control levels for the various indices are adhered to as they are described above (see 5.3.3), meaning that larval control measures are repeated if indices are not satisfactory after breeding site elimination and/or temephos treatment. Mr. Villegas Trejo emphasises that the operational control levels used to be higher, but that Mexican health authorities adjusted them to a lower level some years ago. This happened as several outbreaks were observed in Mexico even though the indices were registered as satisfactory.

6.3.2.2.2. Establishment of new indices

Entomological surveillance in Mexico is in a process of change, says Mr. Villegas Trejo. A lot of entomological data that are collected are actually not thoroughly analysed, he says, and

also points to that there are no studies that directly correlate the *Stegomyia* indices and the number of dengue cases, at least no convincing correlation has been established in Mexico. Attempts to establish better entomological indices are currently being made in Morelos, carried out by the CERECOVES. Both projects using ovitrap data and pupal survey investigations are done. These are further described below in the section on the CERECOVES (see 6.4.5.1 and 6.4.5.3).

6.3.3. Insecticide spraying

6.3.3.1. ULV indoor spraying

In accordance with the SSM Action Programme and SSA manuals, ULV spraying with portable equipment is performed as a control measure secondary to the detection of a DF or DHF case, as described above (see 5.4.3.1). However, the SSM Action Programme specifies that spraying should take place whenever a *probable* case of dengue is reported, covering the four or five houses surrounding the one where the probable case was reported. This should also happen at the latest five days after the report. These new routines, Mr. Villegas Trejo says, were introduced in 2008 in relation with the massive outbreak. The leader of the Regional Vector Control Centre (CERECOVE) in Cuautla, MSc Mrs. Mariana Irina González Fernández, specifies that the actual routine is that the spraying should be performed on the following day whenever a probable case is reported. Insecticide spraying is performed by the aforementioned brigades organised at the jurisdictional level (6.3.1.2), and the section of epidemiology at the jurisdictional administration is also the institution responsible for making sure it is carried out. The brigades now have good coverage and routinely perform spraying only one day after the report, says Mrs. González Fernández. “Obviously, there are still some deficiencies; we do not have a hundred percent coverage. The ideal situation would be a hundred percent coverage in the probable cases. But yes, this area is being strengthened a lot,” she says. “Why [wait] until the following day? Because the health care centre knows, but the health care centre must tell the jurisdiction. And in the jurisdiction, the dengue area canalises it straight to the sector of vector control, they give them the address. [...] And this is why [spraying] is done the day after, because first you have to tell them, right? The ideal would be [to shorten] these times in order to do it more rapidly, which is what one has been looking into since last year. The times have been shortened a lot, because the communication channels have become a lot better.” If the brigade does not succeed in spraying the premises on the first day, says Mrs. González Fernández, they will return after two or three days. Sometimes, however, for whatever reason they do not get to spray on the second attempt. “If you could not [spray on the second attempt], and you are a perfectionist, the ideal would be returning to that house. And that is the intention. But after a week, it does not make sense to go back, because if that patient was finally confirmed to have dengue, in one week transmission will already have happened – and the point of spraying is to cut off transmission.”

6.3.3.2. Large-scale spraying

When it comes to large-scale spraying, a massive spraying programme was carried out in the first three months of 2009, after a plan set forth in the SSM Action Programme. 74 locations of strata 1 and 2, constituting 26 265 hectares, were to be covered in three spraying cycles. This was carried out after the plan, says Mr. Villegas Trejo. The background for this, he explains, was a joint consideration from the federal health authorities and SSM that the dengue transmission situation in Morelos was out of control during the 2008 outbreak. The massive spraying cycles were performed to try to lower the population of dengue-infected mosquitoes at a time of extraordinarily high transmission. Spraying trucks were borrowed from the state of Guanajuato and from federal health authorities, in addition to the 18 already

possessed by Morelos, to carry out the plan. This was, in fact, says Mr. Villegas Trejo, an extraordinary control measure, and no similar spraying cycles are planned at the moment. “Now we are not fumigating actively with heavy machinery,” he says, “because we do not have active transmission. So we do not have to contaminate the environment, and spend a lot of money – for this is expensive.” However, he emphasises that this is subject to change. “We have to make strategies accordingly as time goes by, observing. You know, in the art of epidemiology nothing is written down beforehand, right? If we had known at the beginning of last year that we were going to have the problems we had, we probably would have bought thirty pickups already then.”

6.3.4. Biological control measures

Mrs. González Fernández of the CERECOVE Cuautla states that no biological control measures are routinely implemented in Morelos at the time. However, some trials have been carried out. This is treated in the section on the CERECOVE (see 6.4.5.2).

6.3.5. Control measures during outbreaks

During dengue outbreaks, as Mr. Villegas Trejo explains, the situation is closely monitored at state level (see 6.2.8). However, he says, the main focus of this is to ensure that control measures are carried out in accordance with the routines, rather than implementing any special measures. He emphasises that, above all, it is important to ensure that no errors or omissions are currently being committed in the control work, and if there are, these should be corrected. One would also have to consider specific problems that may lead to loss of control of the outbreak, says Mr. Villegas Trejo, e.g. insecticide resistance in the mosquito population. However, extraordinary measures may be implemented if epidemiologists or the vector control sector find it needed. The SSA *Ae. aegypti* control manual⁴¹ also comments on this, indicating that large-scale spraying may be performed either where entomological or epidemiological risk is found to be high. As mentioned (6.3.3.2), the massive spraying cycles of the first three months of 2009 were such an extraordinary control measure, says Mr. Villegas Trejo.

6.4. The Regional Vector Control Centres (CERECOVES)

6.4.1. Organisation

There are two Regional Vector Control Centres (CERECOVES) in Morelos, one in Panchimalco in the county of Jojutla, which is in health jurisdiction II, and one in Cuautla, jurisdiction III. These have been operative since 2007. The staff at each consists of a biologist, a laboratory technician, and a leader with relevant background. The leader of the CERECOVE Cuautla, Mrs González Fernández, herself a MSc in environmental health, explains that the intention is to start a CERECOVE in jurisdiction I (Cuernavaca) as well.

6.4.2. Role of the CERECOVES

CERECOVE as an institution is not mentioned in federal norms or guidelines. The CERECOVES, Mrs. González Fernández tells us, were organised by the Morelos state government as an effort to strengthen the knowledge base regarding vector work in the state of Morelos, in response to a need felt by the SSM. The main purposes of the CERECOVES, she says, are to do research related to the operative needs of the SSM, and provide information to make well-founded decisions on the administrative level. The same is also emphasised by Mr. Villegas Trejo. Furthermore, he explains that the CERECOVES are independent of the other structures of the vector control sector. This means that they have no direct connection with the vector control brigades at jurisdictional level, and answer directly

to him at state level. According to Mrs. González-Fernández, a separate institution was needed to be able to carry out research projects, as all resources allocated to the other SSM institutions involved in vector control work are consumed by the routine activity demanded of them, leaving nothing for research. The CERECOVES therefore have to seek funding elsewhere for research projects. Several of their projects have been funded by a federal organ not related to the SSA, the Mexican National Council on Science and Technology (Spanish: Consejo Nacional de Ciencia y Tecnología, CONACyT), Mrs. González Fernández explains.

6.4.3. Research

6.4.3.1. Research objectives

The need for doing research that is directly applicable in the vector control work of the SSM, Mrs. González Fernández explains like this: “A lot of research that is done at research institutions is on very specific goals and objectives. And they have resources to do that project. But unfortunately, when you want to apply this in practice, a lot of things cannot be carried out as precisely as when you do a research project, because you need resources.” She explains that they try to do research projects to obtain specifically local results, and exemplifies this with a project they did in three different locations in Morelos, where they sought to identify the most productive types of *Ae. aegypti* breeding sites. “This is in order to get scientific evidence and to give this information to the people in charge, so that decisions [on actions] may be focused on the most productive breeding sites,” she continues. “Thus, [...] they may do specific interventions with the existing resources.”

6.4.3.2. Research areas

Research is done at the CERECOVES on three different areas. One is mosquitoes, including dengue vector *Aedes aegypti* and malaria vectors *Anopheles spp.*, another is the vectors of Chagas’ disease (American trypanosomiasis), which in Morelos means *Triatoma* species, and the last is scorpions. The latter is not properly a vector, but as Mrs. González Fernández explains, it is studied by the CERECOVE because it is also an arthropod of great public health importance – Morelos, incidentally, being home to a range of highly venomous scorpion species (*Centruroides limpidus limpidus* and others)⁴⁴. Only the dengue area will be further commented upon.

6.4.4. Intersectorial cooperation

A goal for the CERECOVES, says Mrs. González Fernández, is to promote cooperation among institutions across sector boundaries. She mentions how they have drawn county authorities into the vector control work: “The Morelos state health law says that counties are obliged to do vector control work. Unfortunately, many of them do not give this the importance they ought to, so we have signed agreements of cooperation with the counties in the state. This is in order to establish some activities where they, for example, can supply manpower for research projects happening in their county.” The CERECOVES have also done research projects in cooperation with Autonomous University of Yucatán (Universidad Autónoma de Yucatán) and the National Institute of Public Health (Instituto Nacional de Salud Pública). On other arenas, the CERECOVES also assist in arranging educational sessions in a variety of settings, e.g. public information meetings after initiatives from local authorities. They are also often contacted by schools, and do a lot of information campaigns there, says Mrs. González Fernández. Getting information out through the school system is a priority for the CERECOVES, she maintains. This will be covered in further detail below (see 6.4.5.4).

Furthermore, the CERECOVES cooperate extensively with the jurisdictional departments for vector control, although they are formally independent of each other. An important task for the centres, says Mrs. González Fernández, is to give information and do educational work internally in the SSM. Specifically, after the outbreak of 2008, when a lot of new vector control workers were hired, the CERECOVES were extensively involved in the education and training of these. The jurisdictional control workers, again, also support the CERECOVES in performing investigations.

Another main partner for the CERECOVES, says Mrs. González Fernández, is the section of health education at state level. Local research results help focus prevention and control campaigns where they have the most impact. Such campaigns in Morelos have, in fact, been designed according to the breeding site profile identified in the state, she maintains.

6.4.5. Concrete projects of the CERECOVE

6.4.5.1. Surveillance with ovitraps

As mentioned above (see 6.3.2.2.2), the CERECOVES carry out entomological surveillance of adult mosquitos through use of ovitraps in sentinel locations. Mr. Villegas Trejo explains that six locations in the state are currently being monitored with ovitraps. These include some stratum 1 locations, but also some locations in the state where dengue has not yet been reported, but where conditions may permit infestation with *Ae. aegypti*. These latter locations are in the cooler areas of Morelos (see 2.6.1.2). With regard to the use of ovitraps, Mr. Villegas Trejo points to one aspect he sees as an advantage: “As a method, it is not sensitive, well, it has some degree of sensitivity, but it is specific. The *Aedes aegypti* is one of the few mosquitoes the lay their eggs in the containers you set out for them as traps. That is an advantage.” Thus, if *Ae. aegypti* eggs are observed in ovitraps in a presumed non-infested location, you have in fact established that the vector is present.

Ovitraps are revised weekly by the CERECOVES. We attended one of these revisions, and were then explained and shown by CERECOVE personnel how they are placed. Approximately a hundred ovitraps are distributed throughout each location. Some blocks are selected on the map of the location, tentatively evenly spaced, and four traps are then placed in each block. Ideally, the CERECOVE personnel try to place them on the corners of the blocks, but as they depend on the permission of the home owners, the best approximation possible is made. Ovitraps are only placed outdoors, not in pairs as described in the SSA dengue manual. The design of the ovitraps deviates slightly from the description in the manual, insofar as the filter paper is attached with a paper clip lining the interior rim of the trap, not wrapped around a spatula and submerged. This adaptation is made by the CERECOVE in order to ease the workload of revising the traps, but also under the assumption that sensitivity will be better, as the *Ae. aegypti* normally deposits its eggs on the walls of the container along the waterline.

The CERECOVES also gather climatic information in these sentinel locations, including temperature and humidity data, and eggs in each ovitrap are counted. The CERECOVES analyse these data, and is currently trying to establish a correlation between these data and dengue incidences, Mr. Villegas Trejo explains.

6.4.5.2. Trials with biological larval control measures

The CERECOVE has, in limited areas, tried to implement biological larval control measures using the fish species *Poecilia reticulata* (guppy). Guppies were distributed among primary school children, who were instructed to place these in water storage facilities at home, and educated on how to take care of them. When houses were later revised by CERECOVE

personnel, in many places the fish were found to have died due to lack of care, Mrs. González Fernández states. SSM has not tried to implement such measures since.

Studies have also been carried out in Morelos using the larvivorous crustacean *Mesocyclops*¹, and *Bacillus thuringiensis*, which is a bacterium pathogenic to mosquito larvae^{14,45}. SSM has, however, concluded that these measures currently are both more work intensive and expensive than chemical larval control, says Mrs. González Fernández.

6.4.5.3. Establishment of new entomological indices and studies of container productivity

A study has been carried out in three different locations in Morelos – Cuautla, Jojutla and Tlaquiltenango – using the number of pupae collected from different containers as a proxy for adult mosquitos produced from the containers. Taxonomic identification of mosquitos hatched from the pupae was done in the laboratory, to determine if the pupae were actually *Aedes aegypti*. Mrs. González Fernández and Mr. Villegas Trejo explain that the study identified water storage facilities as tanks and barrels as among the most productive. A follow-up study is planned for the same locations, where focalised strategies to control the containers identified as the most productive will be implemented.

The quantification of pupae produced by different containers is linked to the topic of establishing new entomological indices, says Mrs. González Fernández, as it may be used in correlation with population density in an area to calculate a *pupae per person-index*, meaning average number of *Ae. aegypti* pupae per inhabitant in an area. Mrs. Villegas Trejo also confirms that the SSM is looking into using this index, which is treated extensively in works of DA Focks et al. This will be treated in more detail below (see 8.4.3).

6.4.5.4. School projects

Mrs. González Fernández strongly emphasises that intervention in schools is a priority area. The CERECOVE has been trying out several varieties of educational programmes in primary schools, where CERECOVE personnel have carried out information campaigns using different pedagogical strategies. Some school programmes are established on a more permanent basis – this will be covered in the section on health education (see 6.5.5).

6.5. Health promotion strategies and community participation programmes

6.5.1. Resources of the health promotion sector

The leader of the SSM section for health promotion, Dr. Eduardo Sesma Medrano, explains that Patio Limpio used to be the only activity of health promotion targeting dengue. Traditionally, he says, budgets for this area have been quite limited, and other health promotion strategies regarding dengue have not been prioritised. This, however, changed after the 2008 dengue outbreak, when funding for dengue prevention activities was substantially increased. Until 2008, there were only 94 so-called *promoters*, health promotion workers, employed in the entire state of Morelos. These were supposed to carry out more than 30 different health promotion programmes in a total of 206 locations (corresponding to the number of health care units in the state), including the Patio Limpio programme. However, in conjunction with the outbreak another 100 were hired, says Dr. Sesma Medrano. Health promotion work targeting dengue has now been intensified and covers a range of different activities, which are described below.

6.5.2. *Patio Limpio*

6.5.2.1. *Coverage*

The community participation programme *Patio Limpio*, as described above (see 5.5), is implemented in Morelos, says Dr. Sesma Medrano. Each promoter has traditionally had a goal of having thirty activators, translating to a coverage of thirty city blocks. However, promoters regularly report problems reaching this number. Dr. Sesma Medrano estimates that most recruit maximum ten activators. Furthermore, a lot of the activators do not follow up the activities that are asked of them. They perform inspections in the neighbourhood only very sporadically, and do not report as they should to the promoters. Thus, a lot of promoters have personally taken over and inspected the areas that their activators should cover, says Dr. Sesma Medrano. As a result, he maintains, the *Patio Limpio* programme currently has a fairly low coverage in Morelos, and even if all promoters were to recruit 30 activators, it would still be low compared to the sheer number of houses in Morelos all together. The *Patio Limpio* efforts that exist, thought, are concentrated primarily in areas of high entomological indices as reported by the vector control section, according to Dr. Sesma Medrano.

6.5.2.2. *Community workshops and recruitment of activators*

Regarding the community workshops, Dr. Sesma Medrano states that they have improved communication with the population on health issues. “Traditionally, we had educational sessions. Or rather informative sessions, you could not call them educational, because the promoter would stand in front of a waiting room in a health care unit and start talking. ‘Dengue is this, dengue is that,’ and so on. And whatever people picked up, whatever information got through, that was what they ended up with.” Now, they are arranged using computer presentations, and are more interactive, as people are taken to street, and engaged to participate in the elimination of breeding sites under instruction of the promoter, says Dr. Sesma Medrano.

The community workshops are to a great extent arranged as a part of a programme of the Ministry of Social Development, *Oportunidades* (i.e. Opportunities). This is a programme for the non-insured parts of the population, that in Morelos thus pertain to the SSM, where they receive certain economic benefits if they comply with a specific health promotion programme. This includes attending a certain number of workshops yearly on health subjects, which are arranged at their local health stations. Among the workshops that they have to attend, according to Dr. Sesma Medrano, is the one on dengue.

As community workshops are largely arranged through *Oportunidades*, most of the activators for the *Patio Limpio* programme are thus recruited from the participants of *Oportunidades*, says Dr. Sesma Medrano. A lot of activators, being recruited from underprivileged populations, resultantly have low levels of education. Dr. Sesma Medrano explains how they needed to make changes in the forms the activators use for data collection: “As a lot of the activators do not know how to read or write, we have put drawings on the forms, so that they can identify visually what they have to mark off and supervise.”

Traditionally, activators have also been recruited through so-called local health committees, a group of volunteers organised by each health care centre, to plan health care activities in the neighbourhood in cooperation with the professional health workers, says Dr. Sesma Medrano. Every health care centre has the responsibility to organise such a committee. The local health committees would traditionally cooperate in arranging community workshops for *Patio Limpio*. Participation in these committees was relatively popular until a few years ago, he says, as they had economic responsibilities, administering parts of the funds allocated to the health care centres. Thus, membership in the committees was related to a certain status, says Dr. Sesma Medrano. Now, however, this responsibility has been taken away from them, and

participation has dropped markedly, he continues, for this and other reasons which will be treated below (see 7.7). In many places, the committees are currently not even in function.

6.5.3. The “Public Buildings Free of Breeding Sites” programme

The SSM section of health promotion is now, in addition to Patio Limpio, managing another programme aimed at keeping public buildings free of *Aedes aegypti* breeding sites, says Dr. Sesma Medrano. The actions of breeding site elimination and control to be taken are basically the same as described for the Patio Limpio programme, he explains. This “Public Buildings Free of Breeding Sites” programme (Spanish: “Edificio Público Libre de Criadero”), however, is aimed at all buildings and premises, including e.g. parks and cemeteries, that are the property of the state or the counties. This is an activity organised at county level. The counties employ additional promoters for this purpose. About half of the counties affected by dengue are participating in this programme.

The promoters of the programme inspect if the public buildings and places in their area are free of breeding sites, and if they are not, the responsible for the localities are given a warning, Dr. Sesma Medrano explains: “They leave them recommendations – you have to throw this, you have to turn this over, you have to put a lid on that. They tell them they will come back, [...] and give them a time frame to correct whatever is not right.” If the problem is corrected upon the next visit, the promoter is satisfied, he says, “but if not, they repeat the recommendations, and notify them that they have to fix it until next time. And they classify [the institution in question] as reluctant.” Those listed as reluctant may again, says Dr. Sesma Medrano, be turned over to another government institution, Civil Protection (Spanish: Protección Civil), that has legal authority to impose sanctions if corrective measures are not taken until the next visit. Those that do pay attention to the recommendations the first time are, on the other hand, officially listed as “Public Buildings Free of Breeding Sites”. “A ceremony is carried out, where they are awarded with a diploma, a certificate, that they may put on the wall for people that visit to say: ‘okay, they do care about us’,” says Dr. Sesma Medrano.

6.5.4. Public information campaigns

6.5.4.1. Means of communication

Information campaigns to the public are now the most important aspect of the health promotion work regarding dengue prevention, Dr. Sesma Medrano says. Much work is now done in this area, on a variety of arenas. The work of the health promotion section, he emphasises, is to achieve a change in the mentality and conduct of the public, in order for them to take responsibility for cleaning their own premises without the intervention of others (see 7.6.1). They also have to make people realise that dengue prevention measures are taken for their own benefit, Dr. Sesma Medrano emphasises.

An array of fliers, posters and other information material on dengue has been designed and distributed on a large scale throughout the state. One of the most successful information material designs, Dr. Sesma Medrano states, was an information brochure made for the schools, where a slip was attached for the parents to sign. This brochure was distributed to the children, and the teachers could subsequently ensure if the information had in fact reached the home of the pupil by collecting the slips.

Television and radio advertisements have also been extensively used to spread information about preventive measures against dengue, Dr. Sesma Medrano explains. For example, when Mexico plays international football matches, a newsfeed is regularly displayed across the screen, showing the slogan of the dengue prevention campaign. Information is also given on the website of the SSM, says Dr. Sesma Medrano, and a free-of-charge dengue hotline has been established to answer questions from the public.

Morelos also receives a lot of tourists on weekends, because of the proximity to the capital, says Dr. Sesma Medrano. In order to reach these people that come to Morelos from other states, and are thus not regularly exposed to information on dengue, large banners were at a time placed at the toll plazas on the highways entering the state, and messages regarding dengue were displayed on the large traffic information screens present on many roads. Currently, he continues, the SSM plans to carry out information activities on malls and commercial stores on weekends, to reach visitors that are not normally reached by larval control workers simply because they are not in the state on weekdays.

6.5.4.2. Message profile and slogans

6.5.4.2.1. Development of the main message

Over the last few years, the message promoted by the SSM in dengue prevention information campaigns has been gradually refined, according to Dr. Sesma Medrano. In 2006, the main focus of campaigns was on spreading information on the disease itself, including symptoms, signs, and the fact that it was spread by a mosquito. “But we never told them what to do to avoid getting ill,” he continues, “we only told them to see their closest health care unit. And, well, when people got ill they went to the health care unit.” For the following year, however, the focus of the campaign was to connect the presence of larvae with the disease. A very popular campaign was launched, says Dr. Sesma Medrano, aimed at children. Children were given T-shirts and badges identifying them as “no-larvae-inspectors” (Spanish: “inspector cero-cero-maromero”, literally “inspector double-0-larva”), and told how to identify mosquito larvae. However, a systematic approach was still lacking, he states, as the campaign did not contribute to elimination of breeding sites, only casual actions against larvae that were found by coincidence.

In 2008 the focus of the campaign was reevaluated again, and shifted to the breeding sites, and adopted its current profile, says Dr. Sesma Medrano. Breeding sites, he emphasises, after all is the primary attack point when seeking to limit vector proliferation. A slogan was developed that would appear on all information material distributed, as a summary of the message the health promotion section wanted to get out: “Wash, put on a lid, turn upside down and throw” (Spanish: “Lava, tapa, voltea y tira”). The slogan was based on the assumption that at some point more detailed information on how to prevent dengue vector proliferation would have reached the public, and that the repetition of the main message would be sufficient.

Another slogan was also developed in order to try to change the mentality of the public, Dr. Sesma Medrano explains: “We are all in it against the dengue” (Spanish: “Contra el dengue vamos todos”). This, he continues, is in order to address another major problem in dengue prevention: “A belief exists among people, and they will say it to you openly, that ‘this dengue thing is exclusively the county’s problem’, or of the health authorities. That is why we wanted [...] ‘We are all in it against the dengue’. With ‘we’, I am primarily talking about the population, and secondly about the county, state and federal authorities, and the health authorities.”

6.5.4.2.2. Attempts to ensure uniform information

An issue addressed by Mr. Villegas Trejo, Mrs. González Fernández as well as Dr. Sesma Medrano is the importance of giving uniform information to the public in order to avoid confusion. “The same messages that are given in the educational materials should be given in the community workshops and told to people,” says Dr. Sesma Medrano, “and the same information should be given in advertisements on radio and TV, and in newspapers and interviews given by spokespersons. We have tried to get the counties to respect this too. There

must be one sole message. No one should change it or modify it after their taste, or else, it will have little penetration among the families.” Mr. Villegas Trejo and Mrs. González Fernández emphasise that information given on breeding site elimination also must target the correct ones, and that this must be based on evidence from the area, as discussed in the section on the CERECOVES (see 6.4.3.1).

6.5.5. School programmes

Involving the schools in the dengue prevention work is an issue of great importance to the SSM. This is mentioned both by Mr. Villegas Trejo, Mrs. González Fernández and Dr. Sesma Medrano. Some concrete programmes have been developed on this area, in addition to the information work done by the CERECOVES as mentioned above (see 6.4.5.4). In relation with the “Public Building Free of Breeding Sites” programme, an agreement has been made with the primary education institutions of the state that time should be dedicated every Monday to breeding site elimination activities, involving both teachers and pupils. Promoters visit the schools on a regular basis to support the work and give information, and also to revise them, and declare them “Public Buildings Free of Breeding Sites”, if applicable. This work is important, says Dr. Sesma Medrano, because schools are in fact a focus of infection if the vector is present there. Every time schools are closed, he states, the number of new cases in children under eleven drops.

Another aspect of the work in schools, Dr. Sesma Medrano emphasises, is that it permits the spread of information to the homes through the children, as mentioned above. The SSM has developed an information programme of one week, which is offered to the schools throughout the state. This, preferably, is to be carried out between the fourth and the sixth year of primary school. The information programme consists of one day with information on the vector itself, one day on the biological cycle of the vector, one for description and practical work with prevention measures, one for symptoms and signs of the disease, and finally, one day for summing up, when a drawing competition is arranged. An important additional activity on the fourth day, as Dr. Sesma Medrano emphasises, is that the parents are invited to listen to the children as they present the importance and relative simplicity of preventive measures in the home. “And then, the parents sort of end up defenceless, right?” he says. “Without the possibility to say no. Because their own children are telling them what to do.” They are then, he implies, more liable to let larval control workers revise their patios at a later time.

Most primary schools accept to carry out this information programme, according to Dr. Sesma Medrano. Not much work is required from the teachers, he says, as ready-made manuals, information material and computer presentations are available. However, some schools decline to do it because of lack of time, he states. This has particularly been a problem if schools have been closed for a period for some reason, e.g. because of strikes.

A group that is generally more difficult to reach, he says, are adolescents in high schools and universities. “There, we are working more with information material, and we have made [give-away] bracelets concerning dengue. There is a university radio station, Radio Universidad UAEM, that students listen to, that is constantly playing the dengue jingle,” he continues. “Still, we have not quite found the way to reach the students. They are, in a way, less preoccupied with [health issues], and not as involved.” However, the higher education institutions have less problems when it comes to breeding sites than primary schools, he states, as they generally have more resources for cleaning and maintenance.

6.5.6. Work aimed at local authorities to improve infrastructure

6.5.6.1. Infrastructure

An important part of the work of the SSM health promotion section is to influence other public service departments not pertaining to the health sector, according to Dr. Sesma Medrano. A well-known problem in dengue epidemiology is the association of high risk areas with scarce infrastructure^{7,8}. As Dr. Sesma Medrano says, Morelos is no exception. The outskirts of Cuernavaca and Cuautla, including Cuernavaca's suburb Temixco, are areas that have had particularly high numbers of dengue cases. "The county that was most affected last year was Temixco. This county has grown in an unplanned fashion, without urban planning. There are irregular settlements of people that have migrated from other states. Very poor people, living in very poor conditions. They have been settling down in an irregular manner, in areas without public services."

This scarcity of infrastructure must be remedied through cooperation with local authorities, he emphasises. "To get mosquitoes, you need breeding sites," he says. "If we take away the breeding sites, well, there would be no mosquitoes. But why are there breeding sites? Because people have to store water for their activities – to shower, to do the dishes, to wash their clothes, even for their daily consume. That is why they store water. So then, what do we need to do? We have to work with county authorities to ensure that people actually have water for their everyday use. So that they can only open the faucet, the water comes, and they close it." In the same areas that lack water supply, Dr. Sesma Medrano continues, garbage collection is often also sporadic or absent, which makes containers accumulate that may potentially become breeding sites.

6.5.6.2. Container collection programmes

In order to help eliminate breeding sites, the SSM has worked with local authorities to organise container collection programmes in certain areas, according to Dr. Sesma Medrano. These programmes are currently not permanent, but the SSM is working towards this goal, he says. Special container collection trucks have been collecting items considered as potential breeding sites during the first few months of the year, prior to the rain season. In previous years, he continues, these trucks would often fill up very rapidly, since people did not distinguish them from the garbage trucks. Now, however, better information is given in order for people to separate containers in disuse from other garbage, and only empty containers are accepted. Information messages, and collection dates, are announced by cars fitted with loudspeakers that pass through the neighbourhoods some time before the collection trucks.

7. Reports and observations on experiences with the dengue prevention, surveillance and control programme in Morelos

7.1. Sources of information

In this section, we will present comments made by the informants as to how the dengue surveillance, prevention and control programme is implemented in Morelos. This will include descriptions of experiences made by the different sectors of the SSM, but also assessments regarding the effectiveness of the different parts of the programme, and identification of problem areas as made by the informants. Much of the information presented in this section is information we have found to be of a more subjective nature, as opposed to the tentatively more descriptive previous section. Nevertheless, some of the information on problem areas is of a descriptive character. Due to its close linkage with assessments made by the informants, we found it natural to include it here. By any means, due to the second-hand nature of information provided through interviews, a clear-cut distinction between facts and personal

opinions on behalf of the informants is difficult to establish. This, however, is an inherent limitation of the method we have chosen.

As a supplement to the information extracted from the interviews, we have included some personal observations made during our stay.

7.2. On epidemiological surveillance

7.2.1. Sensitivity and efficacy of epidemiological surveillance

According to Dr. Bello Martínez, awareness of dengue, and clinical suspicion among physicians, has risen after the outbreak in 2008. “Probably, we were not prepared for what dengue was about, now we know, everybody knows. [...] You can see how the detection of cases has increased.” Until week 27, when the interview was made, 3 791 cases were entered as probable, and out of these only 268 had resulted positive. Dr. Bello Martínez relates this relatively low fraction of positives out of tests taken to awareness among the clinicians that a febrile presentation may be DF, which makes them more liable to send a sample for laboratory diagnostics whenever a patient presents with fever. She also tells us, cases are practically not registered as suspicious. Rather, if there is clinical suspicion of DF, a test would be taken anyway and the case notified as probable.

Thus, Dr. Bello Martínez states that the sensitivity of the epidemiological surveillance of dengue has in fact increased a lot due to the high awareness of the clinicians. This applies even though specialised monitoring clinics for active identification are not implemented (see 6.2.8), she specifies. Mr. Villegas Trejo also comments upon this subject. He states that the architecture of the epidemiological surveillance system has been adequate for some time, including before the outbreak of 2008, but that the efficacy of compilation and analysis of data on a higher administrative level has improved greatly during the last year, as awareness of the need to do this has increased. This, in his opinion, ensures that decisions made regarding interventions are now more soundly founded. In addition, as Mrs. González Fernández commented (6.3.3.1), routines for case notification are more effective than before.

Also in less formalised settings, we have experienced that awareness of dengue among clinicians is currently high in Morelos, as we assess it. During visits to first line health institutions, and in informal conversations with clinicians in private settings, dengue has seemed to be a main topic of interest to them. Several have also explicitly mentioned that they send samples for dengue diagnostics of almost any febrile patient.

7.2.2. Introduction of the NS1 serological test for dengue diagnostics

The introduction of the NS1 serological test last year has made it possible to confirm the diagnosis of dengue earlier, as it may be performed during the first five days of symptoms, in contrast to the traditional IgM tests, which could only be expected to be positive five days or more after symptoms appear⁷. As Dr. Bello Martínez points out, this has led to a quicker registration of cases. Nevertheless, control measures are carried out even before the laboratory results from the NS1 test are finished. Thus, it has actually not had impact on the handling of probable cases, according to her. The difference has only been noted on the level of epidemiological analysis.

7.2.3. The Unified Information Platform

According to Mr. Villegas Trejo, the introduction of the Unified Information Platform has contributed to that epidemiological data are now registered in a more homogenous fashion, which again eases their analysis. However, he points out that it would be even more efficient if data were also allowed to flow horizontally, meaning that one could access the data of neighbouring administrative entities on the same level, thus being able to analyse the local

epidemiological situation more efficiently. Currently, the hierarchic organisation of the system prevents this. “The director, or the epidemiologist, of Jurisdiction I does not have access to the data from Jurisdiction II. They have it [on federal level], but what do they need it for? I do not understand why they have information from the entire country as long as the epidemiologist does not know what happens in the neighbouring jurisdiction or state.”

He also comments, on general grounds, on the fact that the register contains sensitive personal data on a large number of persons, which may be quite easily accessed on various administrative levels. This, in his opinion, calls for a lot of caution to ensure the protection of the privacy of the individual.

7.3. On entomological surveillance and control

7.3.1. Usefulness of the *Stegomyia* indices

Mr. Villegas Trejo on several occasions comments upon that the *Stegomyia* indices have definite weaknesses, among them that they do not quantify the number of larvae present. However, as mentioned above (see 6.3.2.2.1), he emphasises that they do have some validity for estimating where there are risk areas for transmission: “Just by common logic: if you have a house with six containers with larvae, it means that the vector is spreading, it is colonising, and it has breeding sites.” However, both Mr. Villegas Trejo and Mrs. González Fernández emphasise the need to develop better indices that predict dengue transmission risk with greater strength. They currently used indices are actually not even specific for *Aedes*, Mrs. González Fernández comments, as mosquito larvae are not classified taxonomically when indices are registered. Thus, the CERECOVE is doing investigations in this area, she says, more specifically they are, as mentioned (see 6.4.5.3), looking into the pupal survey-indices.

7.3.2. The problem of unavailable premises (“closed households”)

A problem reported by Mr. Villegas Trejo, Mrs. González Fernández as well as Dr. Sesma Medrano, is the one of premises unavailable to the larval control workers. One problem is that people in the larger cities sometimes are reluctant to let strangers into their houses, and deny the larval control workers access. Another is that people simply are not there when the entomologists come to visit. People, for one thing, work the same hours as the larval control workers. Mrs. González Fernández exemplifies this with the Cuernavaca suburb Temixco, where people are hardly ever at home during daytime. A comment on the account of the authors: this must be contrasted with other areas of Mexico of higher socioeconomic status, where a family member, a maid or caretaker is often present during daytime. To remedy this, proposes Mrs. González Fernández, the larval control workers might work differentiated schedules, according to what times people are actually at home.

Morelos is also, as mentioned above (see 6.5.4.1), a state where a lot of people, especially living in the capital, keep weekend houses. These houses, according to Dr. Sesma Medrano, are generally situated in urban areas like Cuernavaca, Cuautla, Xochitepec or Yautepec, that is, in areas with high incidences of dengue (see 2.6.3). During workdays, these houses are either closed down and thus unavailable, the informants explain, or guarded by a caretaker that may not let anybody in without the consent of the patron. As mentioned above (see 6.5.4.1), these houses are especially targeted through own information campaigns.

7.4. On efficacy of control measures

7.4.1. Confounding factors when assessing efficacy of control interventions

All informants acknowledge, and comment upon, the role of immunity against the DENV serotype currently circulating in Morelos with regard to the decrease in the number of cases in

2009. The population is now immunised to a great extent, having been exposed to DENV-1 with or without clinical disease. When the number of susceptibles falls below a certain level, outbreaks limit themselves, and fewer new cases occur. This fact, as the informants emphasise, complicates any effort to estimate the effect of control interventions. Another fact emphasised by Dr. Sesma Medrano, is the historically cyclical nature of dengue epidemics. Transmission will continue to be low, he says, until a new DENV serotype reaches Morelos.

7.4.2. Use of insecticides

7.4.2.1. Large scale spraying

Even though there are confounding factors, Mr. Villegas Trejo expresses that he has reason to believe that the large-scale spraying cycles in the first trimester of 2009 had effect. In his opinion, these cycles had large coverage due to the resources put into this extraordinary measure, and coincided with a gradual drop in the number of reported dengue cases. However, he is wary to establish a definitive link between the spraying cycles and the drop in dengue cases *post factum*.

Mrs. González Fernández remarks that the trucks sometimes find it difficult to cover all areas that they are assigned, because of the mere shape of the city blocks. Spraying schemes are developed with the notion that all city blocks are rectangular, which is hardly the case anywhere, and certainly not in the sprawling conurbations in Morelos. This may affect coverage in some areas, she says. Another problem encountered during spraying with trucks, says Mrs. González Fernández, is that people close all doors and windows believing that the insecticide is harmful, rather than opening them and letting the insecticide pass into the house, as proposed in information material distributed by the SSM. The magnitude and impact of both of these mentioned problems is not further specified by our informants.

7.4.2.2. Urgent spraying of houses where dengue cases are reported

This is an effective measure both in the opinion of Mr. Villegas Trejo and Mrs. González Fernández. Mr. Villegas Trejo emphasises the importance of the new spraying routines, because transmission can be prevented at an early stage, when there is still only a suspicion that it might be dengue. He also comments, though, upon the fact that dengue can easily be confounded with many other febrile diseases, and that they treat a large amount of premises that they in retrospect would not need to. He points to that out of several thousand probable DF cases reported in 2009, only a few hundred have turned out to be confirmed.

The long term impact of the new spraying routines is still difficult to evaluate, as the informants acknowledge, but both Mrs. González Fernández and Mr. Villegas Trejo emphasise that the theoretical argument is strong that transmission could be stopped early, if notification routines and response are effective.

7.4.2.3. Choice of insecticides

As mentioned above (see 5.4.3.3), official Mexican norms no longer specify what insecticides to use by preference, but a list of approved substances is published by the SSA. Mr. Villegas Trejo, however, expresses concern about the fact that documentation presented for the effect of phenothrin on *Aedes aegypti* is scarce. In his opinion, the recommendations made by federal authorities constitute a violation of current official Mexican norms as long as they do not present convincing documentation that phenothrin is in fact fit for the use in dengue vector control. On these grounds, the SSM vector control section, in cooperation with the CERECOVES, is currently performing a series of cage bioassay insecticide tests to determine the efficacy of phenothrin on *Ae. aegypti*. The authors attended one of these tests. Test methods were, as far as we could judge, in accordance with WHO norms for insecticide

testing⁴⁶. Spraying efficacy was only tested on cages located outdoors, not indoors. Results are still unpublished.

7.5. On socioeconomic aspects affecting dengue prevention and control work

Dr. Sesma Medrano emphasises the link that exists between poverty, analphabetism, lack of education and unplanned urbanisation. This again, as mentioned (see 6.5.6.1), is linked to scant infrastructure and favourable conditions for dengue vector proliferation, as seen especially in the conurbations around Cuernavaca and Cuautla. Dr. Sesma Medrano, Mr. Villegas Trejo and Mrs. González Fernández all emphasise the importance of education and the need to involve schools in the dengue prevention work. “Poverty and hygiene are not necessarily related,” says Dr. Sesma Medrano, “you may be poor, but hygienically organised.” The problem is, he emphasises, if you lack basic knowledge about hygiene.

Another problem is that people in risk areas often are very poor, and not willing to part with their belongings during the container collection programmes. “Sometimes things appear useless to us, good-for-nothing things standing around in the patio for more than a year,” says Dr. Sesma Medrano, “but to them it is their heritage. Like a cauldron, for example. ‘Why don’t you throw it away, Madam?’ ‘Well, because I’ll be using it again!’ Who knows when. But at the moment, it is a breeding site.”

7.6. On cultural aspects affecting dengue prevention and control work

7.6.1. Passivity due to paternalistic politics – the belief that everything is the responsibility of the government

Both Mr. Villegas Trejo and Dr. Sesma Medrano mention that, as they call it, the paternalistic dengue control policies of previous years have been very detrimental to prevention work. Previously, Dr. Sesma Medrano says, authorities have given the impression that they were able to control the dengue problem through top-down strategies. As the population grew, however, the capacity of governmental agencies to actually carry out control interventions themselves has been surpassed. However, the population has become passive, he says, and are now expecting that the authorities still somehow intervene to control the dengue problem, not willing to participate themselves. A lot of people, as mentioned, (see 6.5.4.1), think that dengue prevention of control is exclusively the responsibility of the authorities. Dr. Sesma Medrano emphasises that achieving a profound change of mentality is one of the major tasks of the health promotion sector.

7.6.2. The impact of information

Dr. Sesma Medrano explains that a survey was done during the outbreak of 2008, in order to find out how much information was actually reaching the public. “We found out that there was no statistically significant connection between what people know and what people do. They know a lot about dengue. They know about the mosquito, they know it has an aquatic phase with larvae, they know about the symptoms, they know they should not self-medicate. But when it comes to conducts, we can not seem to explain why they do not do what is necessary to keep their houses clean, and not have breeding sites. There is no correlation. And there is no explication to why they do not apply it when they know a lot.”

7.7. On Patio Limpio

7.7.1. Reluctance to participate in Patio Limpio

A major problem of the community participation programme, Patio Limpio, is that people are simply not participating. This is commented upon extensively by Dr. Sesma Medrano. This is not exclusively a problem in Morelos, he says, the same is reported from every state of the country. As previously mentioned (see 6.5.2.1), activators are few, and they carry out their tasks sporadically. There are various reasons that people are reluctant to take part in Patio Limpio, he says. Some cultural aspects are important, he emphasises, which will be treated below (see 7.7.2 and 7.7.3).

7.7.2. Non-acceptance of the population of being judged by their peers

A problem commented upon both by Dr. Sesma Medrano and Mrs. González Fernández, is that people do not easily accept being supervised and judged by their peers. “It is difficultly achieved that someone voluntarily performs such a service, going to their neighbours, commenting on the risks they take by having breeding sites at home,” says Dr. Sesma Medrano. “Actually, nobody will just open the door and say: ‘come on in’. In a way, the programme is not socially well-accepted. [...] When one neighbour comes to supervise another, he does not have the moral authority to say: ‘now, look, you’ve got this and that lying around, throw it away.’ Well, now, who are you to tell me, then? [...] Also, the patio is in the back, or upstairs. It is something very private, where people do not let others in. It costs people a lot to let others in for them to judge them.”

7.7.3. Scepticism towards others in urban areas

Furthermore, both Dr. Sesma Medrano and Mr. Villegas Trejo mention that a lot of areas in Morelos, among them Temixco, are populated by immigrants from other states. Many people abandoned Mexico City after the major earthquake of 1985, and a lot of people are currently arriving from the poorer state of Guerrero. The areas and neighbourhoods where these people settle down, both Dr. Sesma Medrano and Mr. Villegas Trejo propose, may lack local identity. People may lack the sense of belonging to the community where they live, and therefore be less liable to get involved in the community. In some places, people are also, as mentioned (see 7.3.2), highly sceptic to letting strangers in out of fear that their intentions may not be good. Resultingly, Dr. Sesma Medrano says, in some areas there is a strong culture of keeping to yourself, not involving yourself in your neighbours’ matters.

7.7.4. The impact of poor economy

Another factor which may inhibit people from participating in voluntary work, is the matter of a poor personal economy, says Dr. Sesma Medrano. Particularly after the impact of the global financial crisis of 2008-09 this has been felt by the promoters when trying to recruit activators, he states. “Everybody is looking for work and trying to find ways to bring money home,” he says. “They could do [Patio Limpio work] on their spare time, but well, that is their spare time. I do not think anyone would get up, get out and supervise their neighbours instead of resting or being with their family.”

7.7.5. Poor intersubjective reliability of Patio Limpio assessment indices

Mrs. González Fernández remarks that the indices used for assessing the state of patios in the Patio Limpio programme have an important weakness in that they are not very well operationalised. The current classifications that the activators use for collecting data are “good”, “regular” and “bad”, leaving a lot for the activators to interpret for themselves.

Intersubjective reliability is thus low, and the indices have to be refined in order to generate useful data, she says.

7.7.6. Role of the Patio Limpio programme in dengue prevention in Morelos

Health promotion currently has very high political priority as a dengue prevention measure, states Dr. Sesma Medrano; health promotion also including Patio Limpio. As mentioned (see 6.3.1.3), the SSM Action Programme specifies that elimination of breeding sites should happen through participation of the community, coordinated by both health promotion and vector control sectors. The use of insecticides, according to Dr. Sesma Medrano and the SSM Action Programme, is considered a secondary measure. However, Dr. Sesma Medrano sees the need for changes in the implementation of the Patio Limpio programme: “The dengue programme is putting all its hopes in the Patio Limpio programme. It would be worth it to revise the programme on national level. They should make social observations, and anthropological research of the behaviour of people here in Morelos, and Mexico, to get to the bottom of what one could really do to change the behaviour. And thereafter, modify the Patio Limpio programme.”

Furthermore, Dr. Sesma Medrano remarks that community participation programmes are highly cultural-dependent, and that a scheme developed for one country may be entirely unfit for another. He points to that even within Mexico, there are great cultural differences between the regions of the country. Even though programmes are reported to have effect in other Latin American settings, notably Cuba, this may not be transferable to every place where dengue is a problem.

7.8. Other remarks on the dengue prevention, surveillance and control programme in Morelos

7.8.1. Action against specific container types

As Mrs. González Fernández and Mr. Villegas Trejo state, some of the most productive container types in Morelos have been identified. Many of these are in fact to an extent controllable, remarks Dr. Sesma Medrano. This is a promising aspect for future actions to be taken, he says.

7.8.2. Need for top-down strategies in the current situation

Although health promotion and education is the priority strategy in the long run, with the goal of voluntary participation of the community in prevention measures, Mr. Villegas Trejo, Mrs. González Fernández and Dr. Sesma Medrano all comment on the issue that top-down interventions may currently be needed to control the dengue situation.

Mr. Villegas Trejo remarks that the use of insecticides on a certain scale is, and will continue to be, a necessity in Morelos. “Promotion is a very long educational process, and should consider the culture of the region. But we cannot say we are going to control dengue in Morelos with an educational programme, because we are not. We have to use insecticides.”

Both Mrs. González Fernández and Dr. Sesma Medrano remark that the vector control sector lacks authority to intervene where people are not willing to cooperate. Thus, if larval control workers are not let in somewhere, they may have to leave premises unchecked and untreated, although they suspect that they are bypassing a breeding focus. Dr. Sesma Medrano proposes that a possible solution would be to give the vector control sector wider authorities, enabling them to sanction uncooperative households. “People listen more to authority,” he says, “And in quotes, the Mexican is very... well, with threats and punishment things get done. Rather than through asking nicely.” Some places in Mexico, he says, local rules already

give opportunities to sanction households that are considered to threaten the health of the neighbours.

7.8.3. Activity level

It is important, states Mrs. González Fernández, to keep the level of activity in dengue prevention work high all year long. Earlier, she says, actions were only carried out in the rainy season, which would largely mean control measures through insecticide use, rather than preventive measures. From this year, however, budgets allow all components of the dengue programme to function throughout the year, after a massive raise in allocations during and after the outbreak of 2008. According to Dr. Sesma Medrano, 4 million Mexican pesos (approximately 300 000 US dollars) were originally allocated for the dengue programme in Morelos in 2008, and more than 80 million pesos (approximately 6 million US dollars) were finally spent. Mr. Villegas Trejo states that a similar sum of money is allocated for 2009. With the increased budgets, one can avoid that dengue disappears from the consciousness of people between the outbreaks, says Mrs. González Fernández. “You have to be like a drop constantly falling,” she says, “always, always, always, always.”

Furthermore, both Mrs. González Fernández and Dr. Sesma Medrano mention that the activity level regarding dengue prevention work was somewhat affected by the outbreak of the H1N1 influenza in April 2009. Some resources, particularly those of the health promotion workers, were then diverted into the prevention campaign targeting the influenza. Furthermore, many dengue information posters and banners in public places were swapped for influenza information. The SSM again felt the need for more promoters, states Dr. Sesma Medrano, but information on dengue was one of the areas that were prioritised even though resources were strained. Thus, other health promotion programmes of the SSM were affected a lot by the influenza outbreak; the dengue information work, however, not as severely, according to Dr. Sesma Medrano.

7.8.4. Vaccine trials

A tetravalent dengue vaccine developed by Sanofi is due to be tried out in Morelos shortly, informs Dr. Sesma Medrano. The protocol for clinical trials is currently in the process of being approved by Mexican health authorities.

8. Discussion

8.1. Limitations

Due to the subjective nature of how data are registered during interviews, no qualitative study may be conducted in a completely unbiased way. All results we present are thus liable to have been misinterpreted or distorted. However, we have tried to minimise potential sources of bias through recording and transcribing the interviews, thus making them available for more thorough evaluation.

Also, in any qualitative study, the possibility of reporting bias is present; i.e. it is impossible to ensure that all data are presented in a complete fashion by the informants. However, we have no impression that the informants in our study have been reluctant to share information, rather the opposite. We have, as thoroughly as possible, tried to ask concrete questions when we have felt the need to clarify any issues. On a general basis, background knowledge about the issues treated during the studies also helps prevent reporting bias, as one is more aware of in which areas information may be lacking.

Selection bias is also a possible source of errors; meaning that we may not have found a representative selection of informants that might provide us with relevant information. This,

however, we have tried to remedy through purposeful sampling of key informants, as treated in the section on methods (see 3.6.1).

Furthermore, our selection of informants is small, for reasons given in the section on methods (see 3.6.1). Although we have made the assumption that the key informant approach would give information in a more refined fashion, meaning that we have assumed that SSM leaders would possess more concentrated information on the issues we have examined, a small selection makes the study more vulnerable to errors such as interviewer bias (see 3.6.3) and poor recall bias. That is, if incorrect information – or information that has in any way been influenced or distorted by factors such as interviewer interventions – has been given during the interviews, it is less likely to have been corrected by other sources.

A process of adaptation of the data material is necessary in order to be able to analyse it. However, as Malterud states, any manipulation of the data material may also distort the intended meaning of it³³ and hence reduce the internal validity³⁵. The recording, being an indirect representation, is stripped of context and non-verbal communication, the text transcribed from the recording is without the tone of voice. The process of selecting quotes for use in the written work of the researcher leads to a certain loss of material; the analysis and translation into English alter the text directly³³. These factors together may lead to a distorted or incomplete representation of what has actually been said in the interview.

During direct observation, a potential problem is that one attributes a different meaning to the phenomena observed than the participants do, due to a different frame of references. Data collected through observation may also be influenced by the mere presence of the observer, as the behaviour of the observed persons may change in this setting³³.

Lastly, observing the programme as foreigners may have advantages and disadvantages. Cultural differences may complicate the interpretation of data. However, the authors have some prior knowledge of Mexican conditions, having visited Morelos on several occasions, thus being able to apply some hermeneutical techniques during interviews as well as data interpretation. The upside of arriving from the outside as an observer is that one may notice aspects that are generally accepted implicitly and go unnoticed by native workers.

8.2. General impression of the dengue prevention, surveillance and control programme in Morelos

The dengue problem in Morelos has received a lot of attention in the course of the last few years. This, in our opinion, is also reflected in how the dengue prevention, surveillance and control programme is currently operating. Awareness of the need to work with the dengue issue seems to us to be high in all sectors that constitute parts of the programme, and they seem to us be working actively across these sectors to achieve an impact on the epidemiological situation in the state. During our stay, and through analysis of the interviews, we have been given the impression that the implementation of the programme is constantly assessed and evaluated, to guide actions to where they may have the most impact. Public health workers we have spoken to, including our informants, are knowledgeable in the area and updated on current issues in their respective sectors. As we see it, the dengue programme in Morelos is more extensive than the requirements of Mexican norms on many areas.

8.3. The dengue prevention, surveillance and control programme in Morelos seen in the light of national and international guidelines

All components listed in the Decalogue⁸, including the specifications according to PAHO sources (see 2.4.2), are in fact addressed by the dengue programme in Morelos, except the one regarding sentinel clinics, and possibly on the subject of evaluation of insecticides. However,

monitoring of fever of unknown origin is carried out on a large scale in the first-line health services, although no specific monitoring clinics are organised. These points are also where the dengue programme in Morelos deviates from national Mexican norms.

8.4. Specific aspects of the dengue programme in Morelos in the light of literature

8.4.1. Epidemiological surveillance

Improvements seem to have been made lately in Morelos on the area of epidemiological surveillance. Seemingly, awareness of dengue in first-line health services is in fact high, thus increasing the probability of detecting cases, i.e. the sensitivity of the surveillance. Also, information handling routines have been improved, most notably through the introduction of the Unified Information Platform. The systematic collection of data on dengue cases through standardised forms, as well as the registration in the platform, ensures that homogenous data are recorded. Along with sensitivity, a systematic approach to data collection is one of the factors affecting the quality of a surveillance system, according to Runge-Ranzinger¹⁶ and Magnus³⁵. Using standardised forms with checkboxes may also contribute to the simplicity of operation of the system, also a factor to take into account when assessing its efficacy³⁵. Standardised forms with case definitions operationalised through checkboxes also ensures that they definitions are applied correctly. In a dengue surveillance settings, lack of knowledge about the definitions among first-line health personnel could else lead to unreliable surveillance data⁵.

Generally, the public health sector in Morelos does seem willing to participate in the dengue surveillance – another criterion for good surveillance^{16,35}. The private sector, however, has been very reluctant, a well-known problem from dengue surveillance programmes⁶. This leads to loss of epidemiological data, which affects the ability to implement effective control measures.

A so-called endemic channel, i.e. a window of relative normality regarding the number of cases in endemic areas, is being used to separate seasonal variations from outbreaks. This is also important for the dengue surveillance system to be useful for making decisions¹⁶.

The positive predictive value of the surveillance system should also be considered^{16,35}. In the case of Morelos, numbers from this year until July 15th show that it was only 7% (see 7.2.1), meaning only this fraction of reported probable cases turned out to be confirmed. However, a high number of cases falsely reported as positive may be the price for ensuring that less cases are overlooked, thus increasing the sensitivity of the system³⁵. Increasing knowledge among the population about dengue, which seems to be the case in Morelos, makes people more prone to seek medical attention when they experience dengue-like symptoms. Thus, sensitivity may also increase, while the positive predictive value of the surveillance decreases¹⁶.

The specificity of the system, that is the ability to distinguish between outbreaks of dengue and other illnesses¹⁶, is ensured by sending samples for laboratory testing. As we see it, the introduction of the NS1 serological tests, with a specificity of up to 100% in studies^{47,48}, has also increased the overall specificity of the surveillance system. Now, confirmation or invalidation that it is in fact a dengue outbreak may be attained more rapidly, not having to wait for the IgM titres to rise in affected patients. This enables authorities to change control strategies more rapidly if it is *not* a dengue outbreak.

The representativeness, that is the ability of the surveillance system to detect cases throughout the whole population^{16,35}, is more difficult to assess. Certainly, SSM has an active strategy to screen for dengue in febrile patient in the population it caters to. The IMSS and ISSSTE are also reporting cases at a rate roughly corresponding to the percentage of the population they serve (see 2.6.2 and 2.6.3.4). A problem area is the part of the population that

are served by private physicians, as these mostly report no cases. Consequently, it is not possible to know how many cases of dengue are not reported by this sector. This could, however, be estimated by conducting limited sample surveys of a number of private physicians, in order to extrapolate the amount of cases not reported by the sector as a whole⁵. In any case, this would not solve the problem of the inability to implement control measures related to the cases of dengue treated by the private sector, it would only contribute to a more accurate assessment of the epidemiological situation.

Incorporation of new knowledge about dengue is ensured through the publication of manuals and guidelines by the SSA on national level and SSM on state level. Documents for the management of dengue surveillance were updated in 2008 and 2009, respectively. The ability to integrate new knowledge in the surveillance system is referred to as its flexibility^{16,35}. In our opinion, for the area of epidemiological surveillance, the guidelines seem to be up to date. As an example, on the subject of case definitions, they deviate from the current norms of the WHO, as more cases are included than WHO definitions would. WHO definitions, however, have been criticised for not being applicable in a clinical setting since haemoconcentration criteria are difficult to establish in clinical settings without access to laboratory facilities. They are also not compatible with fluid treatment^{5,6,11}. The SSA dengue manual explicitly states that case definitions are designed to heighten sensitivity. Another example is that guidelines for laboratory diagnostics are updated, prescribing that NS1 ELISA diagnostic techniques should be used, a technology that has only been available since recently.

On a general note, a problem with dengue epidemiological surveillance systems is that passive surveillance may not be enough to detect an outbreak before it is already peaking, since clinicians are not aware of the possibility of dengue⁸ and accordingly do not classify cases as dengue. This, however, may be remedied in Morelos by the low threshold there seems to be with regard to taking samples for dengue diagnostics, as clinicians are aware of the endemicity of the disease. Thus, screening is to an extent performed on the population of febrile patients. As outbreak studies are performed when a small number of cases registered (as few as two), awareness of the possibility of dengue outbreaks also seems to be high.

Guha-Sapir et al.⁵ propose that the ability to keep mortality from DF/DHF low is in fact a function of the ability of the surveillance system to detect cases early, making rapid medical intervention possible in severe cases. Mortality above 1% is seen to be a result of failure in these routines⁵. When considering mortality of dengue as a proxy for the effectiveness of epidemiological surveillance, zero mortality in Morelos even during the outbreak of 2008, with more than 8 000 cases, indicates that surveillance is in fact functioning well.

8.4.2. Swift spraying response

Efficacy of epidemiological surveillance is also a prerequisite for swift spraying response when probable cases are detected. There is still a need to prove soundly that the new spraying routines implemented in Morelos in fact have an impact when it comes to the limitation of outbreaks. However, the theoretical argument is obvious that quick measures to eliminate infected vectors in case of an outbreak will reduce transmission. Timeliness, that is the time span between the detection of a case until measures are taken, is a determining factor for the usefulness of a dengue surveillance system^{16,35}.

8.4.3. Entomological surveillance

Larval surveillance in Morelos is carried out according to the SSA dengue manual, which prescribes use of the classical *Stegomyia* indices. The SSM vector control sector is aware of the fact that these indices have quite significant limitations. Focks⁴⁹ addresses this problem in a WHO review of current entomological surveillance methods. The *Stegomyia* indices do not take into account important factors when assessing transmission risk such as immunity in the

population as a whole. Susceptibility of the population is normally, along with the number of infectious individuals or vectors⁴⁹ introduced to the population, considered a key variable for estimating transmission risks for infectious diseases. Ignoring the part of susceptibility may lead to invalid estimations.

Furthermore, the classical indices postulate that there is a relationship between the number of infested containers and the population of adult mosquitoes, and between the number of adults and transmission risk. However, studies have not shown any strong relation between these variables. The indices are especially poor when it comes to estimation of transmission risk^{6,49,50}. Nevertheless, when registered before and after larval control interventions – as in Morelos – the indices are useful to assess if the interventions have had effect⁴⁹. Some researchers have maintained that it is possible to establish critical thresholds for dengue transmission in specific geographical areas⁵¹, whereas others^{49,52} argue no such thresholds have ever been established for dengue, only yellow fever, and that transmission has been seen also with very low indices. In any case, the operational index limits for implementing control measures are lower in Mexico than those traditionally used. They are found by the vector control sector to be useful as guidelines for prioritising areas where vector control efforts are going to be carried out, as long as no cost-effective alternative surveillance methods are currently available. This is not only the case in Mexico, the classical *Stegomyia* indices are still used by most vector surveillance programmes due to resource considerations⁸.

As the SSM vector control sector maintains, ovitraps are useful for entomological surveillance in areas where *Ae. aegypti* is scarce, as it has a higher sensitivity than traditional indices⁴⁹. It is also useful for monitoring seasonal variations in an area⁴⁹.

The CERECOVES in Morelos are currently looking into the newer indices that may have stronger predictive values for vector population and transmission risk, including pupal surveys to establish container productivity. Pupae may prove to be a better proxy for adult population for a number of reasons. *Ae. aegypti* pupae do not feed, and mortality in the pupal phase is low, whereas it is impossible to predict how many larvae will eventually emerge as mosquitoes, as their survival is dependent on the larval density in the container. Pupae may also actually be quantified, as opposed to larvae and eggs⁴⁹. Quantification of pupae per person in a geographical area seems to be a more promising method for estimating transmission risks, when it is combined with seroprevalence studies (i.e. immunisation status among the population)⁴⁹. This way of estimating transmission risk lies closer to the classical notion, assuming that risk is determined by the relationship between potentially infectious vectors and susceptible individuals.

8.4.4. Vector control measures

Some of the problems encountered by larval control workers in Morelos are well-known phenomena, such as the increasing number of closed households during daytime^{6,8}. This reduces the efficacy of larval control measures, as many houses are then left untreated.

Evidence for the efficacy of large-scale spraying on transmission is inconclusive¹. However, spraying as an emergency intervention, combined with indoor ULV spraying, is the WHO gold standard⁴. In any case, vector population tends to recover within two weeks⁶, which explains why spraying should be reserved for elimination of infected vectors during outbreaks. The use of phenothrin for large-scale spraying is of concern to the SSM vector control sector, as it may be in violation of Mexican norms. It is of importance that this issue is clarified. The series of insecticide tests conducted by SSM may contribute to this.

8.4.5. Health promotion and community participation

Another prominent feature of dengue prevention work in Morelos, in our opinion, was the emphasis on information campaigns, especially through the educational system, rather than

community participation programmes in the strict sense. Although Patio Limpio is implemented according to national guidelines, it seems to be working ineffectively for a number of reasons (see 7.7).

Reluctance to and lack of motivation for participating in organised community participation programmes of the Patio Limpio type is a well-known phenomenon^{53,54}, especially in populations of low socioeconomic status⁵³, unfortunately the same group where interventions may be needed the most. Achieving sustainability of the programmes is another problematic issue. A systematic review by Heintze et al.⁵⁵ concluded that it is unsure if it is possible to keep community-based programmes operative long enough for them to have a lasting effort on vector infestation. Several studies report that community participation programmes may have an additional effect on traditional *Stegomyia* indices when combined with top-down vector control measures, as compared to top-down measures alone⁵⁵. One study from a Mexican setting, performed in the state of Colima, concluded that spraying measures and educational measures had a negative interaction⁴⁵. An analysis of the cost-effectiveness of horizontal versus vertical vector control programmes in Cuba by Baly et al.¹⁷ concluded that participatory programmes were more cost-effective than top-down measures.

However, our impression is that it is difficult to compare the efficacy of community participation efforts because of the great variations between the cultural and socioeconomic settings where they are implemented. The large number of confounding variables when measuring outcomes of such interventions is also addressed by Heintze et al.⁵⁵. Thus, reports from the health promotion sector should be taken seriously that voluntary participation programmes are in fact not easily implemented in the setting of Morelos. An important aspect to take into consideration, is that the amount of volunteer work needed for implementing a programme such as Patio Limpio also implicates an opportunity cost, in terms of the loss of spare time or potential income carried by the volunteers¹⁷. Also, in order to have a satisfactory coverage of households, a substantial number of promoters would need to be employed, which would constitute a great additional cost to the health sector directly. Thus, an analysis might be needed to consider if resources are not equally well-spent if invested in other educational activities.

In fact, prioritising other educational strategies than Patio Limpio currently seems to be the approach of the dengue prevention programme in Morelos. In the study from Colima, Espinoza-Gómez et al.⁴⁵ found good effect on reduction of breeding sites through educational measures such as house-to-house information visits by trained personnel, educational meetings, and the use of educational material as stickers and calendars with dengue and *Ae. aegypti* themes. This study was found by Heintze et al.⁵⁵, using a numerically operationalised scoring system, to be of high quality regarding study design and reporting quality, as one of the few randomised controlled trials comparing educational strategies and spraying measures. It also has the advantage, when comparing with Morelos, that it is from a Mexican setting. This, in our opinion, provides some support for the strategy of concentrating educational efforts in other areas than Patio Limpio.

Integration of educational measures regarding dengue in the school system, in accordance with PAHO recommendations (see 2.4.2), may also be a promising measure to ensure a long-term impact on the public mentality regarding dengue. As has been reported in many other places, there exists an idea among people that dengue is a problem solely of the authorities^{6,13,54}. This is an important problem to address in dengue prevention work. A change of mentality is needed to make people understand that they have a co-responsibility for controlling the dengue vector. This might be best approached through working towards children and adolescents, as they may be more susceptible to information, and thus more likely to establish good habits for future control of the vector.

8.4.6. Demographic and socioeconomic issues

One of the most critical issues to address in the context of dengue prevention and control, is the demographic situation in Morelos. The dengue problem can never be controlled unless infrastructure as water supply and garbage collection is provided in areas deficient of this. The unplanned urbanisation is one of the key problem areas. There is a need to involve sectors outside the health care system, primarily local authorities, to ensure that the services needed are provided. This need is recognised by the health promotion sector. However, ways must be found to make other sectors assume the responsibility they have in the prevention of dengue – a well-known issue in dengue prevention and control work^{6,20,56}.

8.4.7. Use of top-down vector control measures

At the moment, extensive use of top-down vector control measures, i.e. larval control work through house visits and use of larvicide, seems inevitable. As long as community participation is weak, and the population remains passive, there is still a need to control the dengue vector in some way. This active role of the authorities may of course be reconsidered if educational measures turn out to have a long-term effect on the behaviour of the population when it comes to dengue prevention.

One of the major problems of top-down vector control strategies is the immense need for human resources to cover all households⁶, illustrated by the SSM calculations for larval control workers needed to give an optimal follow-up of the control measures (see 6.3.2.1). Another problem with larval control is that workers are absolutely dependent on the cooperation of the owners of the premises. There may be a need, as addressed by our informants, to implement control measures forcibly, as is done for other infectious diseases that pose a threat to the public. This is also addressed by PAHO and WHO^{21,57}. These organisations suggest changes in legislation in order to make sanctions possible against those who have breeding sites on their premises. Authorities in Morelos may already sanction public institutions through the programme “Public Buildings Free of Breeding Sites”, which may contribute to the efficacy of the programme.

9. Conclusions

In summary, we have found that epidemiological and entomological surveillance is conducted in Morelos according to national and international norms. CERECOVE efforts to establish entomological indices with greater predictive value may help to ensure future efficacy of vector control measures. At the moment, vertical control measures are necessary, as the horizontal community participation programmes are not functioning optimally. However, the use of phenothrin for space spraying is of concern to the vector control sector as it may be in violation of Mexican norms.

The Patio Limpio programme may need revision, due to the problems existing with its implementation on a practical level. However, it is difficult to assess what effect a community participation programme has if it is reproduced in another setting than where it was originally designed and tested.

A change of mentality in the population is needed, but how to achieve it is not easy to establish. Working through schools may be a productive arena. There may be a limit to the effectiveness of voluntary measures. An ability to sanction upon non-compliance may be needed. The ability to sanction may contribute to the effectiveness of the “Public Buildings Free of Breeding Sites” programme.

Most importantly, the problem of dengue is not going to be solved in Morelos until scarcities of basic infrastructure are remedied in problem areas.

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11. Conflicts of interest

The authors are personal friends of the leader of the CERECOVE and the SSM Director of Services to the Community.

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